Mass Flow Controllers

Series FC-77X / 77XX, Series FC-78X / 78XX, and Series FC-79X

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AERA PRODUCTS

User Manual

User Manual

Series FC-77X / 77XX,
Series FC-78X / 78XX, and
Series FC-79X MFCs

ADVANCED ENERGY®

5700512-C

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Chapter 1

Safety and Product Compliance Guidelines

IMPORTANT SAFETY INFORMATION

To ensure safe installation and operation of the Advanced Energy® MFC, read and understand this manual before attempting to install and operate this unit. At a minimum, read and follow the safety instructions and practices documented under "Safety Guidelines" on page 1-6.

MODEL NUMBERS FOR THIS MANUAL

This manual applies to the MFC model numbers shown in the following tables:

- Table 1-1 on page 1-1 shows standard MFC model numbers covered by this manual
- Table 1-2 on page 1-3 shows block-type MFC model numbers covered by this manual
- Table 1-3 on page 1-4 shows high temperature MFCs covered by this manual.

Table 1-1. *Standard MFC model numbers*

Model Number	Control Valve		External Seal		Connector Type
	Normally closed	Normally Open	Metal	Rubber	
FC-770A		x		x	Card edge
FC-770AC	x			x	Card edge
FC-771A		x		x	Card edge
FC-771AC	x			x	Card edge

Table 1-1. *Standard MFC model numbers (Continued)*

Model Number	Control Valve		External Seal		Connector Type
	Normally closed	Normally Open	Metal	Rubber	
FC-772		x		x	Card edge
FC-772C	x			x	Card edge
FC-780		x	x		Card edge
FC-780C	x		x		Card edge
FC-781		x	x		Card edge
FC-781C	x		x		Card edge
FC-782		x	x		Card edge
FC-782C	x		x		Card edge
FC-780X		x	x		Card edge
FC-780XC	x		x		Card edge
FC-790		x	x		Honda 20-pin
FC-790C	x		x		Honda 20-pin
FC-791		x	x		Honda 20-pin
FC-791C	x		x		Honda 20-pin
FC-795		x	x		Honda 20-pin
FC-795C	x		x		Honda 20-pin
FC-796		x	x		Honda 20-pin
FC-796C	x		x		Honda 20-pin
FC-7700		x		x	Card edge
FC-7700C	x			x	Card edge
FC-7700CD	x			x	Subminiature-D
FC-7700CU	x			x	Card edge
FC-7710		x		x	Card edge
FC-7710C	x			x	Card edge
FC-7710CD	x			x	Subminiature-D
FC-7710CU	x			x	Card edge
FC-7720		x		x	Card edge
FC-7720C	x			x	Card edge
FC-7720CD	x		x		Subminiature-D
FC-7800		x	x		Card edge
FC-7800C	x		x		Card edge
FC-7800CD	x		x		Subminiature-D

Table 1-1. *Standard MFC model numbers (Continued)*

Model Number	Control Valve		External Seal		Connector Type
	Normally closed	Normally Open	Metal	Rubber	
FC-7800CU	x		x		Card edge
FC-7810		x	x		Card edge
FC-7810C	x		x		Card edge
FC-7810CD	x		x		Subminiature-D
FC-7810CU	x		x		Card edge
FC-7820		x	x		Card edge
FC-7820C	x		x		Card edge
FC-785		x	x		Honda 20-pin
FC-785C	x		x		Honda 20-pin
FC-786		x	x		Honda 20-pin
FC-786C	x		x		Honda 20-pin

Table 1-2. *Block-type MFC model numbers*

Model Number	Control Valve		Connector Position	
	Normally closed	Normally Open	Vertical	Lateral
FC-7850Y-B		x		x
FC-7850CY-B	x			x
FC-785Y-B		x		x
FC-785CY-B	x			x
FC-786Y-B		x		x
FC-786CY-B	x			x
FC-785X-B		x	x	
FC-785XC-B	x		x	
FC-785T-B		x	x	
FC-785CT-B	x		x	
FC-786T-B		x	x	
FC-786CT-B	x		x	
FC-795T-B		x	x	

Table 1-2. *Block-type MFC model numbers (Continued)*

Model Number	Control Valve		Connector Position	
	Normally closed	Normally Open	Vertical	Lateral
FC-795CT-B	x		x	
Note: All of these models use a Honda 20-pin connector, have metal external seals, and have a connection with a flange fitting.				

Table 1-3. *High temperature MFC model numbers*

Model Number	Control Valve		External Seal		Connector Type
	Normally closed	Normally Open	Metal	Rubber	
FC-780HT		x	x		Card edge
FC-780CHT	x		x		Card edge
FC-781HT		x	x		Card edge
FC-781CHT	x		x		Card edge

INTERPRETING THE MANUAL

The following sections explain the document type conventions and the danger, warning, and caution boxes that provide information about the specific levels of hazard seriousness.

Type Conventions

Please note the following type conventions:

- Pin and signal names appear in capitalized italics (*POWER_ON*).
- New terms appear in italicized text.
- Unit labels (switches, indicators, and so on) appear in boldface text (**MODIFY**).
- Commands (**stx**) appear in boldface, lowercase text.

Danger, Warning, and Caution Boxes

This symbol represents important notes concerning potential harm to people, this unit, or associated equipment. Advanced Energy® includes this symbol in Danger, Warning, and Caution boxes to identify specific levels of hazard seriousness.

DANGER:

DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. DANGER is limited to the most extreme situations.

WARNING:

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and/or property damage.

CAUTION:

CAUTION indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury, and/or damage to property. CAUTION is also used for property-damage-only accidents.

Interpreting Product Labels

The following labels may appear on your unit:

1020

CE label

1027

Refer to manual for more information

SAFETY GUIDELINES

Review the following information before attempting to install and operate the product.

⚠ WARNING:
Do not attempt to install or operate this equipment if you have not first reviewed this manual.

⚠ WARNING:
Hazardous voltages exist inside the mass flow controller (MFC). Do not remove the MFC cover.

- Do not install substitute parts or perform any unauthorized modification to the MFC.
- Service and repair the MFC only at authorized service centers to ensure that all safety features are maintained.
- Do not remove MFC covers. Component replacement and internal adjustments must be made by qualified service personnel only.
- If hazardous materials are used, observe the proper safety precautions, completely purge the MFC when necessary, and ensure that the material used is compatible with sealing materials.
- After installing the MFC, or before its removal from a system, purge the MFC completely with a clean, dry gas to eliminate all traces of the previously used flow material.
- This MFC should be purged by qualified personnel following standard company procedures.
- Do not operate this product in an explosive environment.
- Ensure that all MFC fittings are consistent with MFC specification and compatible with the intended use of the MFC.
- Before proceeding with the MFC setup, carefully check all plumbing connections to ensure leak-tight installation.
- Never operate this MFC at pressures higher than the rated maximum pressure. (Refer to "Model Specifications" on page 6-1 for maximum allowable pressure specifications.)

- When operating from a pressurized gas source, install a suitable burst disc in the vacuum system to prevent system explosion if system pressure rises.
- Do not allow contaminants of any kind to enter the MFC before or during use. Contamination such as dust, dirt, lint, glass chips, metal chips, or any other particles may permanently damage the MFC.

Product Certification

Certain options of this product are certified by:

- CE Marking – Self-declaration, assessed by AE Corporate Compliance

For more information, refer to the Certificate or Letter of Conformity (US) or Declaration of Conformity (EU) accompanying the product.

Conditions of Use

To comply with the stated directives and standards, you must meet the following conditions of use:

- Install and operate this device only in accordance with the listed safety guidelines and all other applicable directives and standards specific to your process and application.
- Dispose of this product as directed by applicable laws and regulations.

Chapter 2

Product Overview

PRODUCT DESCRIPTION AND THEORY OF OPERATION

The MFC provides analog control, an array of possible mechanical and electrical connections, and a wide variety of flow ranges. As shown in Figure 2-1, the MFC (mass flow controller) is composed of a PC board that is integrated with the following sections:

- Flow and temperature sensor
- Bypass
- Electronics
- Control valve

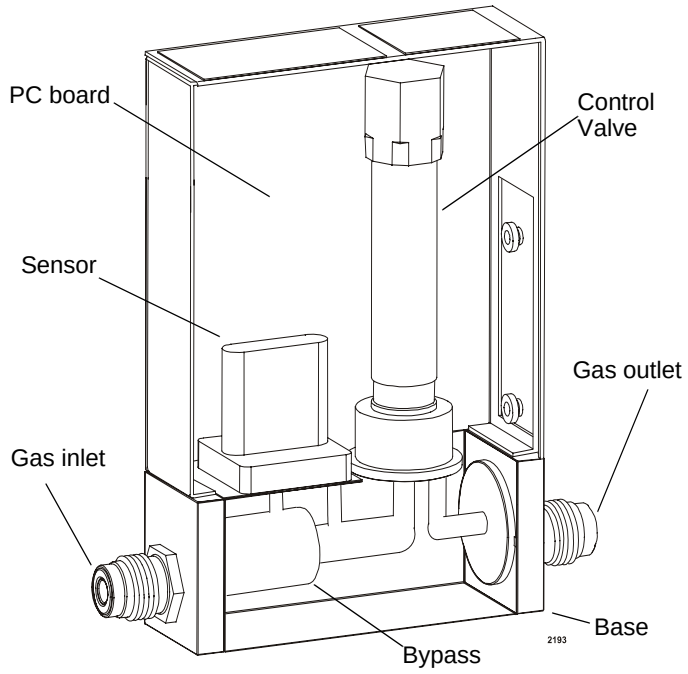


Figure 2-1. *MFC cutaway view*

When gas flows through the MFC it is split into two streams. A larger stream is routed through the bypass assembly, and a smaller stream that is proportional to the larger stream is routed through the flow sensor. The MFC is designed so that the ratio between these two streams remains constant over the entire measurable flow range of the instrument.

The flow sensor measures the flow of the smaller stream which represents the total gas flow through the MFC. The flow sensor consists of a small stainless steel capillary tube with two thermal resistors wound around the outside. Current passes through the thermal resistors that function as heaters to warm the sensor tube. The thermal resistors form part of a bridge circuit that senses the resistors' resistance balance. When gas is flowing, heat is transferred from the upstream to the downstream thermal resistor. The degree of imbalance is proportional to the rate of the gas flow.

The control valve adjusts gas flow through the MFC based on the flow sensor reading and the set point to ensure a stable gas flow from the MFC.

For more detailed information regarding the components in the MFC, see "MFC Components" on page 2-2.

MFC COMPONENTS

The main components of the MFC are the flow sensor, bypass, electronics (bridge, amplifier, and comparator circuits), and valve assemblies. Figure 2-2 illustrates these major components.

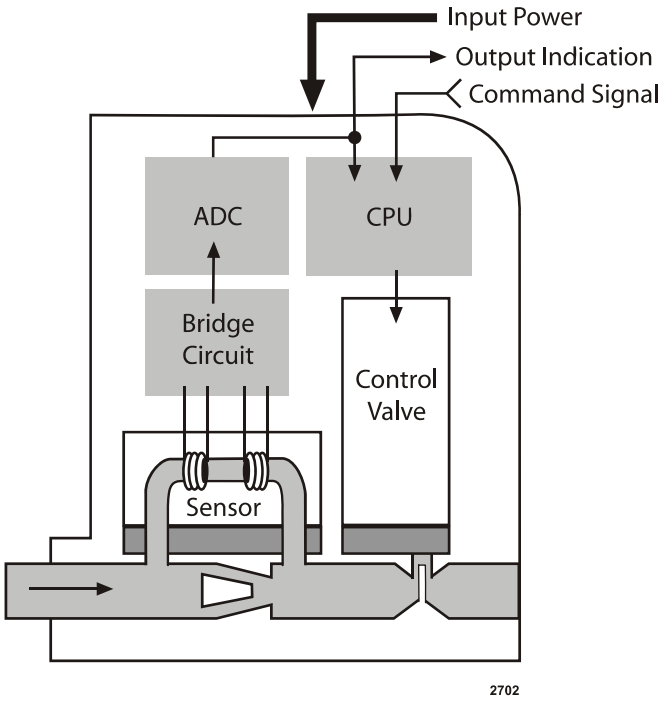


Figure 2-2. *MFC functional block diagram*

Flow Sensor Assembly

The flow sensor consists of a capillary tube wound by two self-heating resistance wires through which electrical current is passed. The resistance wires heat the sensor tube and when gas flows through the flow sensor a temperature differential is produced between the upstream and downstream wires. The temperature change causes a change in resistance which is detected as an electronic signal by the bridge circuit of the electronics assembly.

The MFC uses the mass gas flow measurement because the heat exchange between the gas and the self-heating resistance wire depends on the mass flow. When gas is not flowing, heat is distributed evenly over the upstream and downstream wires, therefore the resistance of upstream and downstream wires is equal and the bridge circuit outputs zero. When gas flows, heat is exchanged between the gas and the self-heating resistance wires. The temperature distribution between the upstream and downstream resistance wires changes causing an imbalance. The imbalance of the upstream and downstream temperatures results in a resistance differential that is detectable by the bridge circuit as an electronic signal. The electronic signal represents the mass gas flow.

As a result of the techniques of thermal mass flow measurement, gas flow can be measured independently of factors which affect volume and density, such as temperature and pressure.

Bypass Assembly

The bypass assembly diverts a small stream of incoming gas through the flow sensor and channels the rest through the bypass and toward the valve assembly of the MFC. The bypass assembly design ensures a constant flow ratio between the flow sensor and the larger flow passing through the instrument, making the output signal of the flow sensor proportional to the total (or mass) gas flow. A comparator circuit in the electronics assembly compares the output signal from the flow sensor and the flow set point. The signal created from this comparison drives the control valve until the difference between the set point and the sensor output signal decreases to zero.

Electronics Assembly

The electronics assembly consists of a bridge circuit, a high resolution analog converter, a valve drive circuit, and an analog I/O. The signal generated by the bridge circuit is amplified and fed into the analog converter which outputs this signal into the CPU (central processing unit). The CPU compares the set point signal to the sensor reading to generate a signal to drive the control valve.

Valve Assembly

The valve assembly consists of a normally closed or normally open, solenoid control valve.

Installation and Operation

PREPARING TO INSTALL THE UNIT

The following sections provide information that you need to understand before installing the MFC.

Installation Requirements

Install the MFC according to the following requirements.

> **WARNING:**
> **Operating and maintenance personnel must receive proper training before installing, troubleshooting, or maintaining this equipment.**

- Do not use this product for medical or life-support purposes.
- Use the appropriate tube size for the MFC fitting.

  The MFC does not come with mounting screws and gaskets. The selection and preparation of appropriate screws and gaskets is your responsibility.

  Note: For product and attachment dimensions, see "MFC Dimensions" on page 6-33.
- Connect the MFC with the gas flowing in line with the arrow marked on the front of the MFC.
- Make the electrical connection according to the instructions in "Making the Electrical Connection" on page 3-5.
- Use optional functions such as error detection and the purge function according to the relevant instructions.
- Perform the gas connector leak test with a helium leak detector.

  Note: For models with a normally closed control, perform the leak test with the valve open (by providing a set point voltage to the MFC).
- After power on, warm up the MFC for at least 15 minutes before supplying gas.

- The MFC can be mounted in any position, but the zero point may shift if the MFC is in a nonvertical position.

  Adjust the zero point in the intended mounting position (see "Zeroing the MFC" on page 3-9 for more information).

- AE recommends that you use a filter on the MFC primary side. A clogged MFC can result in inaccurate control and measurement and subsequent process failures.
- AE recommends that you use a dedicated regulator on the MFC primary side. Excessive service pressure can cause control errors and MFC failure. Unstable pressure (or multiple MFCs below a single regulator) can cause unstable output.

INSTALLING THE UNIT

The following sections explain how to install the unit.

⚠ WARNING:
Hazardous voltages exist inside the mass flow controller (MFC). Do not remove the MFC cover.

Overview of Unit Installation

To install the MFC, do the following:

1. "Confirming the MFC Model" on page 3-3.
2. "Preparing the Installation Site" on page 3-3.
3. "Unpacking the MFC" on page 3-3.
4. "Positioning the MFC" on page 3-3.
5. "Mounting the MFC" on page 3-4.
6. "Making the Mechanical Connections" on page 3-4
7. "Making the Electrical Connection" on page 3-5.
8. "Testing the System for Leaks" on page 3-6.

Confirming the MFC Model

Before you install the MFC, ensure that you have the correct model for your system requirements. The part number, serial number, calibration gas, and full-scale flow are listed on the label of the MFC. See "Product Label" on page 6-40 for an example MFC label.

Preparing the Installation Site

Before installing the MFC, thoroughly clean, dry, and purge all piping associated with the entire flow control system (in accordance with your company's procedures). The MFC control valve is not capable of completely shutting off gas flow. You must install another shut off valve downstream of the MFC to completely stop gas flow.

Unpacking the MFC

> **Configuration Note**
>
> **The MFC is manufactured in a cleanroom environment and delivered in contamination-free packages. Unpack MFC products in a cleanroom.**

Unpack and inspect the MFC carefully, looking for obvious physical damage. If no damage is apparent, locate and save all documentation, and then proceed with the installation procedures.

If you do see signs of shipping damage, contact Aera, an Advanced Energy company, and the carrier immediately (see "AE Global Services" on page 5-6 for contact information). Save the shipping container for submitting necessary claims to the carrier.

Save any undamaged shipping materials in the event you must ship the MFC in the future. For more information on shipping an MFC, see "Packing an MFC for Shipping" on page 5-10.

Positioning the MFC

Position the MFC so the gas flow is in the direction of the arrow stamped on the MFC base. The MFC can be mounted in any position, but the zero point may shift if the MFC is mounted in a non-vertical position. Adjust the zero point in the intended mounting position before running the MFC (see "Zeroing the MFC" on page 3-9 for more information).

Mounting the MFC

Look to the following information to correctly mount the MFC.

Note: If you are using an MFC with IGS connections, you must make the mechanical connections before mounting the MFC. See "Making the Mechanical Connections" on page 3-4 for more information.

Note: The MFC may be retrofitted into any system because it has been manufactured for drop-in replacement for all existing MFCs and is backward compatibility with all older analog MFCs.

To Mount the MFC:

1. Match the mounting holes on the bottom of the MFC with those on the mounting surface.
2. Using two #8-32 UNC-2B screws mount the MFC. Ensure it is securely attached and will resist vibration from external sources.

See "MFC Dimensions" on page 6-33 for dimensional drawings of the MFC, as well as the specifications of the MFC mounting footprint.

Making the Mechanical Connections

To make the mechanical connections for the MFC, connect the inlet and outlet fittings of the MFC to the gas supply line. Depending on the fitting type, use one of the following procedures to connect the MFC.

Note: See "Model Specifications" on page 6-1 for more information about your fitting type.

To Make VCR Fitting Connections:

1. Verify the MFC is correctly mounted (see "Mounting the MFC" on page 3-4).
2. Inspect the tubing, ferrules, and fittings for dirt, dust, contamination, or damage. If necessary, replace damaged components and clean the tubing, ferrules, and fittings in accordance with your company's procedures.
3. Insert associated tubing until it rests flush against the shoulder of the fitting.
4. Tighten nut to finger tight and then 1/8 of a turn past finger tight.

To Make IGS Connections:

1. Inspect the mounting blocks for dirt, dust, contamination, or damage.

   If necessary, replace damaged components and fittings in accordance with your company's procedures.

2. Insert appropriate metal seals for your seal type.

   Note: Metal seals are not included with the MFC.

3. Mount the MFC and tighten screws according to IGS torque specifications (see "Mounting the MFC" on page 3-4).

Making the Electrical Connection

Connect the system to the MFC using an appropriate mating connector and cable. For electrical connector pin and signal information, see Chapter 4, "I/O Connections and Communication."

Note: If possible, securely fasten the connector with jack-post screws to the MFC to prevent the connector from vibrating loose. Signals at this I/O port can be sensitive to electrical noise. Take standard preventative measures against electromagnetic interference (EMI), including using shielded cable.

POWER SUPPLY REQUIREMENTS

For specific power supply requirements, see the specifications for your MFC model in "Model Specifications" on page 6-1.

Note: The power supply used with the MFC must be sufficient to handle the larger current demand during operation. Additionally, the ripple voltage of the power supply should be less than 20 mV.

If needed, Aera recommends using the following Aera power supplies for use with Aera MFCs:

- PS94UA (For use with up to 4 MFCs)
- PS76DA (For use with up to 6 MFCs)
- PS74DA (For use with up to 4 MFCs)

GROUND CONNECTIONS

The MFC employs both signal and power commons. Proper grounding of these common leads is essential for the MFC to operate accurately and safely. Improper grounding practices may result in inaccurate actual and indicated flow. Follow all appropriate industry and local practices and standards in making these connections.

Note: For electrical connector pin and signal information, see Chapter 4, "I/O Connections and Communication."

Testing the System for Leaks

> **CAUTION:**
> **Do not use liquid leak detectors to leak test connections. They may damage the MFC.**

After installing the MFC in your system, you should test the leak integrity of the gas connections with a helium leak detector.

Note: MFCs equipped with a normally closed control valve should be leak tested with the valve open (by providing a set point voltage to the MFC). For more information about setting the set point voltage, see Chapter 4, "I/O Connections and Communication."

CONNECTING THE MFC TO PERIPHERAL EQUIPMENT

The following illustrations provide guidance for connecting a MFC to peripheral equipment. The illustrations list Aera part numbers for equipment.

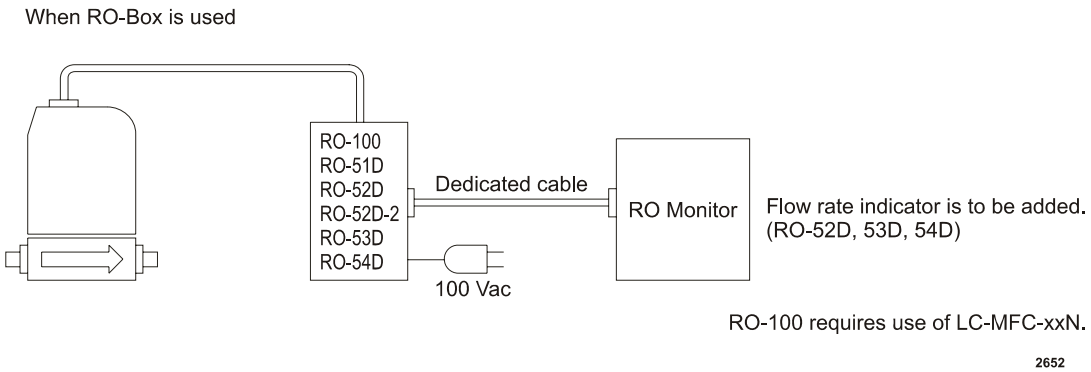


Figure 3-1. *Connection to peripheral equipment using a RO-Box power supply*

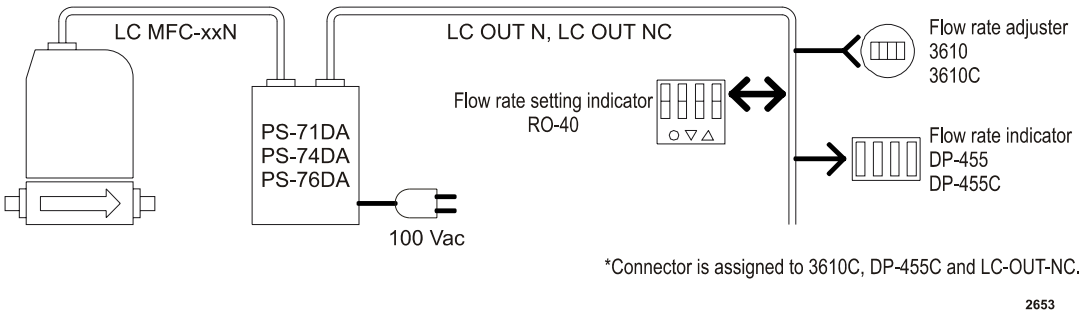
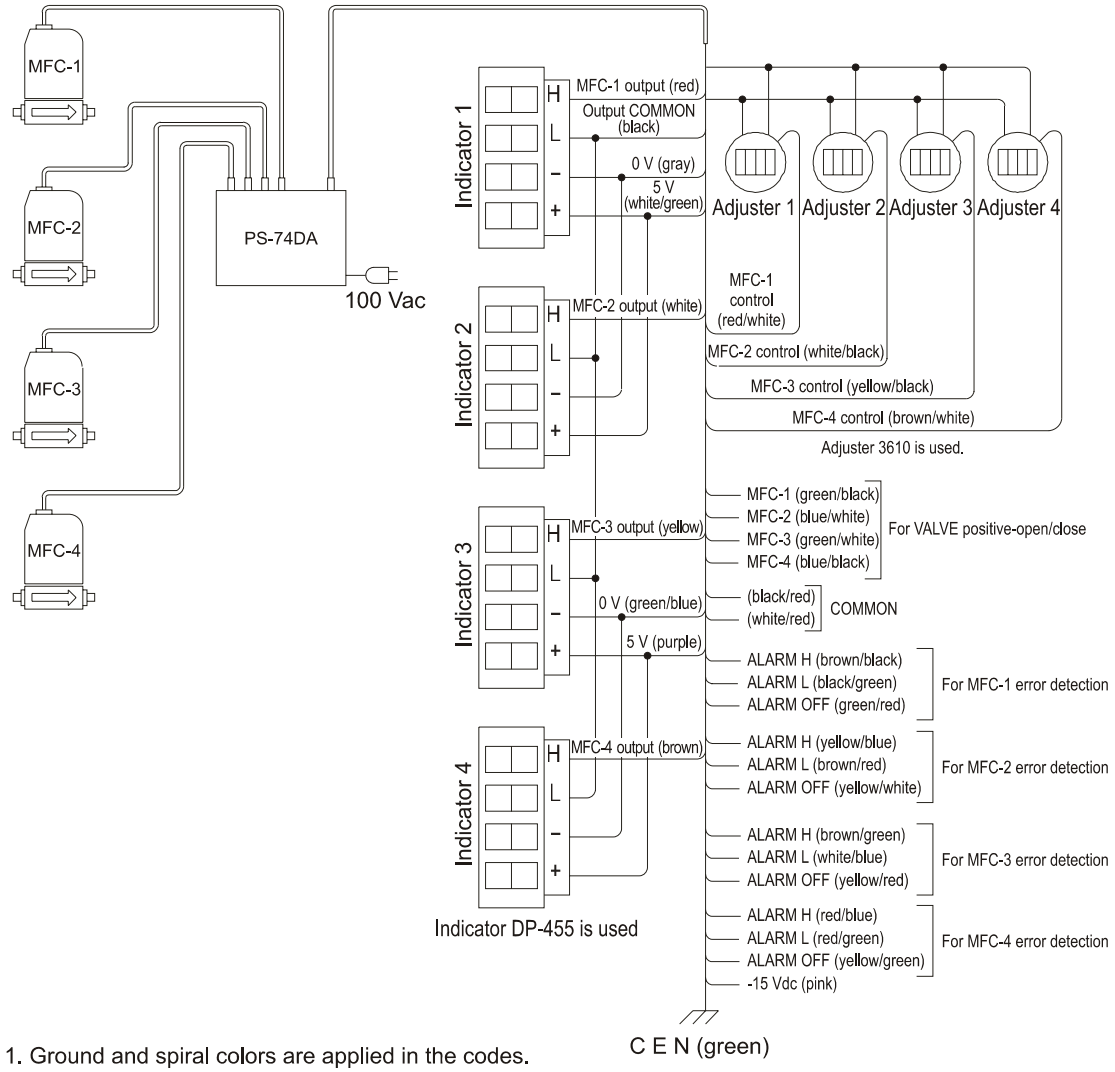


Figure 3-2. *Connection to peripheral equipment using a dedicated power supply*



1. Ground and spiral colors are applied in the codes.
2. Treat the unused terminal of line code LC-OUT-N with care not to establish a short.

Figure 3-3. *Example of connections using dedicated line code LC-OUT-N*

OPERATING THE UNIT

The following sections explain how to operate the unit.

WARNING:
Hazardous voltages exist inside the mass flow controller (MFC). Do not remove the MFC cover.

First-Time Operation

The first time you operate the MFC:

1. Ensure that you have installed the MFC properly by following the procedures in "Installing the Unit" on page 3-2.
2. After energizing the MFC (turning on power) through the appropriate communications interface, allow the MFC to warm up for at least 15 minutes before supplying gas to the MFC.

   If you observe deviation in the zero output, perform a zero-point adjustment (see "Zeroing the MFC" on page 3-9).
3. When using the MFC with vapors at room temperature, set the supply pressure at the minimum value capable of securing the full-scale flow rate to avoid liquid recondensation in the pipes. Be sure to maintain stable temperature for all pipes.

Zeroing the MFC

Look to the following information to adjust the MFC to the zero point.

Note: Contamination can negatively affect proper flow rate control and measurement, despite zero point adjustment.

Before Zeroing the MFC, Review the Following:

- Make sure that your MFC has a zero-point adjustment hole. To identify this hole, see Figure 3-4 on page 3-10. If your model does not have this hole, you can not adjust the zero point. In this situation, contact AE Global Services (see "AE Global Services" on page 5-6).
- The MFC can be mounted in any position. However, if the MFC is in a vertical position, thermal siphoning can occur with a gas that has a molecular weight that is 140 or less, which may cause the zero point to shift. Make sure to adjust the zero point in the intended mounting position and with pressured service gas.
- Adjust the zero point at the service operating temperature. Temperature deviations, even within the specified range of operating temperatures, may cause the zero point to shift.

To Adjust the MFC Zero Point:

1. Make sure that the MFC has reached ambient temperature.
2. Energize the MFC, then wait at least 15 minutes. During this time, make sure that the ambient temperature remains constant and that the output stabilizes.
3. Close the shut-off valves upstream and downstream of the MFC to ensure that there is no gas flow.
4. For normally closed MFCs set the set point signal to 0 V. For normally open MFCs, set the set point signal to 5 V. For more information on the set point command, see Chapter 4, "I/O Connections and Communication."
5. Use a small, flat head screw driver to make the zero-point adjustment as shown in Figure 3-4.

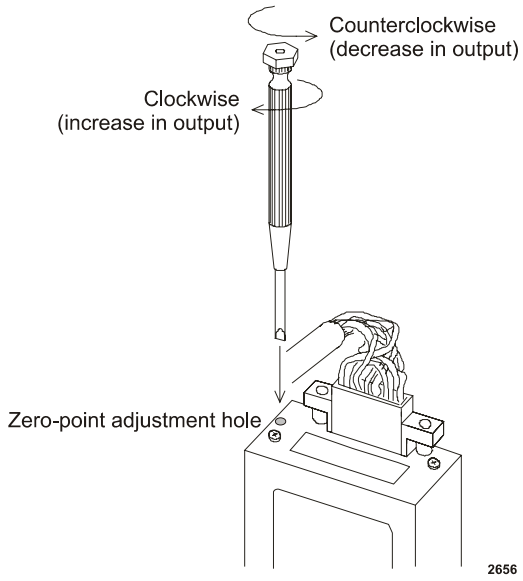


Figure 3-4. *MFC zero point adjustment*

MAINTENANCE

Recalibration and repair should be performed by Advanced Energy. See "AE Global Services" on page 5-6 for contact information.

Note: Removal of an MFC should be done only after adequate purging with a nonreactive gas such as nitrogen gas (N_2). You should follow your company procedures for removing gas line components.

Reactive gas calibrated MFCs may receive severe contamination or corrosion from exposure to air or moisture. Check plumbing for leaks, and purge thoroughly with dry nitrogen before operating or disconnecting from the system.

STORAGE

Observe the following requirements when placing an MFC in storage:

- Temperature between 5ºC (41ºF) and 45ºC (113ºF)
- Relative humidity less than 60%

Additionally, prevent any mechanical impact or corrosion.

Chapter 4

I/O Connections and Communication

The following sections provide information on the MFC's electrical connectors and communication interfaces for MFC control, read back, and alarm indications.

20-PIN CARD EDGE CONNECTOR AND 20-PIN HONDA CONNECTOR

Card Edge Connector

Figure 4-1 shows the pin names on the card edge connector.

1	A
2	B
3	C
4	D
5	E
6	F
\	\
8	J
9	K
10	L

Figure 4-1. *20-pin card-edge connector*

Honda Connector

Figure 4-2 shows the pin numbers on the 20-pin Honda connector.

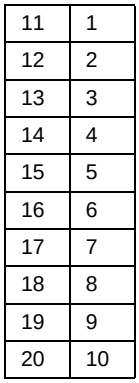


Figure 4-2. *20-pin Honda connector*

20-Pin Connector Signal Descriptions

Table 4-1 provides the pin and signal descriptions for the 20-pin card-edge connector and the 20-pin Honda connector.

Table 4-1. *20-pin connector signal descriptions*

Pin	Signal Name	Signal Description
1	*CASE GND*	Case ground terminal. This terminal is connected to the base of the MFC. All other terminals must be insulated from this terminal.
2	*POWER COMMON*	Common line that carries the majority of the MFC operating current. *Note:* *POWER COMMON* (pin 2) and *SIGNAL COMMON* (pins B and C for the card edge connector, pins 12 and 13 for the Honda connector) must be connected at the power supply.

Table 4-1. *20-pin connector signal descriptions (Continued)*

Pin	Signal Name	Signal Description
3	*OUTPUT*	Flow output terminal. Flow is represented by a signal scaled between 0 VDC and 5 VDC: • 0 VDC = 0% • 5 VDC = 100% of full-scale flow
4	*+15 VDC*	For specifications on this signal, see the supply power section of the specifications table for the specific MFC model (see "Model Specifications" on page 6-1).
5	*UNASSIGNED*	This pin is unassigned and should *not* be connected.
6	*VALVE TEST POINT*	Terminal for monitoring the voltage of the valve drive. The scale is 0 VDC to -13 VDC (maximum valve voltage).
Key (card edge) 7 (Honda)	*KEY* or *UNASSIGNED*	The key is a slot in the card-edge connector that ensures the connector can not be connected backwards. For Honda connectors, this pin is unassigned and should *not* be connected.
8	*ALARM H*	This pin provides an alarm output, which does not need to be connected. For more information see "Alarm Output (Error Detection) Signals" on page 4-7.
9	*ALARM L*	This pin provides an alarm output, which does not need to be connected. For more information see "Alarm Output (Error Detection) Signals" on page 4-7.
10	*ALARM OFF*	This pin resets the alarm signal on pins 8 and 9. It does not need to be connected. For more information see "Alarm Output (Error Detection) Signals" on page 4-7.

Table 4-1. *20-pin connector signal descriptions (Continued)*

Pin	Signal Name	Signal Description
A (card edge) 11 (Honda)	*SET POINT INPUT*	Analog flow control set point signal. The signal range is 0 VDC to 5 VDC: • 0 VDC = 0% • 5 VDC = 100% of full-scale flow
(card edge) 12 (Honda)	*SIGNAL COMMON*	Return for control signals. *Note:* *POWER COMMON* (pin 2) and *SIGNAL COMMON* (pins B and C for the card edge connector, pins 12 and 13 for the Honda connector) must be connected at the power supply.
C (card edge) 13 (Honda)	*SIGNAL COMMON*	See pin B (12)
D (card edge) 14 (Honda)	*VALVE OPEN/ CLOSE*	This signal controls the position of the control valve and allows you to use the purge function on the MFC. The controls for this function vary with connector and MFC type. For more information, see "Control Valve Purge Function Signals" on page 4-8.
E (card edge) 15 (Honda)	*UNASSIGNED*	This pin is unassigned and should *not* be connected.
F (card edge) 16 (Honda)	*-15 VDC*	For specifications on this signal, see the supply power section of the specifications table for the specific MFC model (see "Model Specifications" on page 6-1).
Key (card edge) 17 (Honda)	*KEY* or *UNASSIGNED*	The key is a slot in the card-edge connector that ensures the connector can not be connected backwards. For Honda connectors, this pin is unassigned and should *not* be connected.
J (card edge) 18 (Honda)	*UNASSIGNED*	This pin is unassigned and should *not* be connected.
K (card edge) 19 (Honda)	*UNASSIGNED*	This pin is unassigned and should *not* be connected.
L (card edge) 20 (Honda)	*UNASSIGNED*	This pin is unassigned and should *not* be connected.

9-PIN SUBMINIATURE-D CONNECTOR

Connector

Figure 4-3 shows the pin numbers on the 9-pin subminiature-D connector.

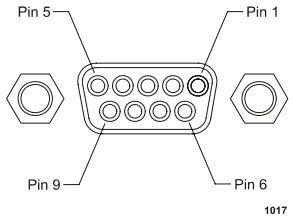


Figure 4-3. *9-pin subminiature-D connector*

Pin and Signal Descriptions

Table 4-2 provides the pin and signal descriptions for the 9-pin subminiature-D connector.

Table 4-2. *9-pin connector signal descriptions*

Pin	Signal Name	Signal Description
1	*VALVE OPEN/ CLOSED*	This signal controls the position of the control valve and allows you to use the purge function on the MFC. • Open = Common or +15 VDC • Closed = -15 VDC • Normal = Floating For more information, see "Control Valve Purge Function Signals" on page 4-8. *Note:* Complete shut off of a gas cannot be achieved by the control valve of an MFC.
2	*OUTPUT*	Analog flow output signal. The signal range is 0 VDC to 5 VDC: • 0 VDC = 0% • 5 VDC = 100% of full-scale flow
3	*+15 VDC*	For specifications on this signal, see the supply power section of the specifications table for the specific MFC model (see "Model Specifications" on page 6-1).
4	*POWER COMMON*	Common line that carries the majority of the MFC operating current. *Note:* *POWER COMMON* (pin 4) and *SIGNAL COMMON* (pins 7 and 8) must be connected at the power supply.
5	*-15 VDC*	For specifications on this signal, see the supply power section of the specifications table for the specific MFC model (see "Model Specifications" on page 6-1).
6	*SET POINT*	Analog flow control signal. The signal range is 0 VDC to 5 VDC: • 0 VDC = 0% • 5 VDC = 100% of full-scale flow
7	*SIGNAL COMMON*	Return for control signals. *Note:* *POWER COMMON* (pin 4) and *SIGNAL COMMON* (pins 7 and 8) must be connected at the power supply.

Table 4-2. *9-pin connector signal descriptions*

Pin	Signal Name	Signal Description
8	*SIGNAL COMMON*	See pin 7.
9	*VALVE TEST POINT*	Test point signal indicating the position of the control valve: • Open = -13 VDC • Closed = 0 VDC

SPECIAL FUNCTION SIGNAL DESCRIPTIONS

The following sections provide detailed signal information for signals that are dedicated to specific functions.

Alarm Output (Error Detection) Signals

Not all MFC models provide these signals. To see if your model provides alarm output signals see the specifications for the MFC model in question (see "Model Specifications" on page 6-1). For signal descriptions, see Chapter 4, "I/O Connections and Communication."

FC-77X and FC-77XX MFCs provide error detection as a standard feature. The function is an option on some other models.

For MFCs with the error detection feature, the MFC provides alarm output if it detects a difference between the flow rate set point and the actual flow rate for longer than eight seconds.

As shown in Figure 4-4, *ALARM H* and *ALARM L* are connection terminals for the open collector that is isolated with the photocoupler. To use the terminals, apply appropriate power, as shown in the illustration. Use the *ALARM ON/OFF* signal to reset the signal.

Note: If no gas is being supplied, but the MFC has a nonzero set point, the MFC will report an error (because the flow rate does not match the set point).

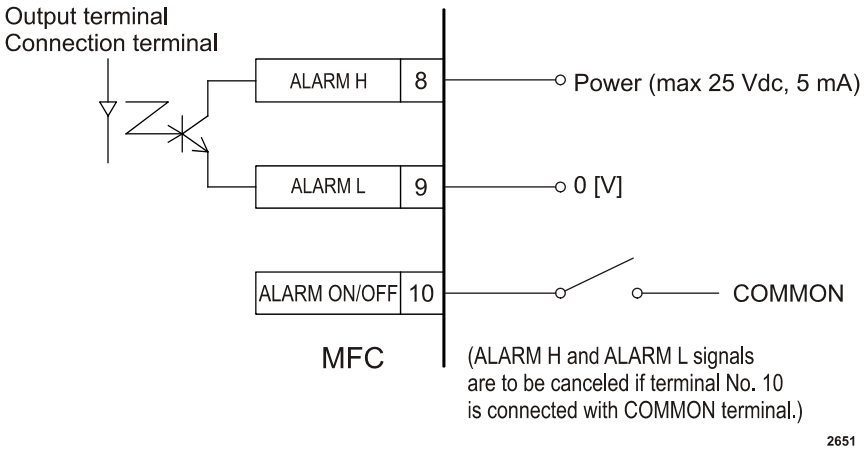


Figure 4-4. *Alarm connection*

Control Valve Purge Function Signals

The control valve purge function allows you to completely open the control valve and purge gas at many times the MFC full-scale flow rate. This function is particularly useful for purging gas when using MFCs with a low full-scale flow rate or for leak checking. The settings for opening/closing the control valve vary with the connector type and, in some cases, with whether the MFC is normally open or normally closed. *For most applications, this signal is not connected.*

The following illustrations show the connection and the internal MFC wiring, for the purge function signals on all connectors.

CARD EDGE PURGE FUNCTION SIGNALS

For the card edge connector, MFCs with normally open and normally closed valves require inverse connections. Be sure to connect the signal properly. (To check whether an MFC is normally closed or normally open, see "Model Numbers for this Manual" on page 1-1.) Figure 4-5 shows the connections. Figure 4-6 and Figure 4-7 show the internal circuitry for normally open and normally closed MFCs, respectively.

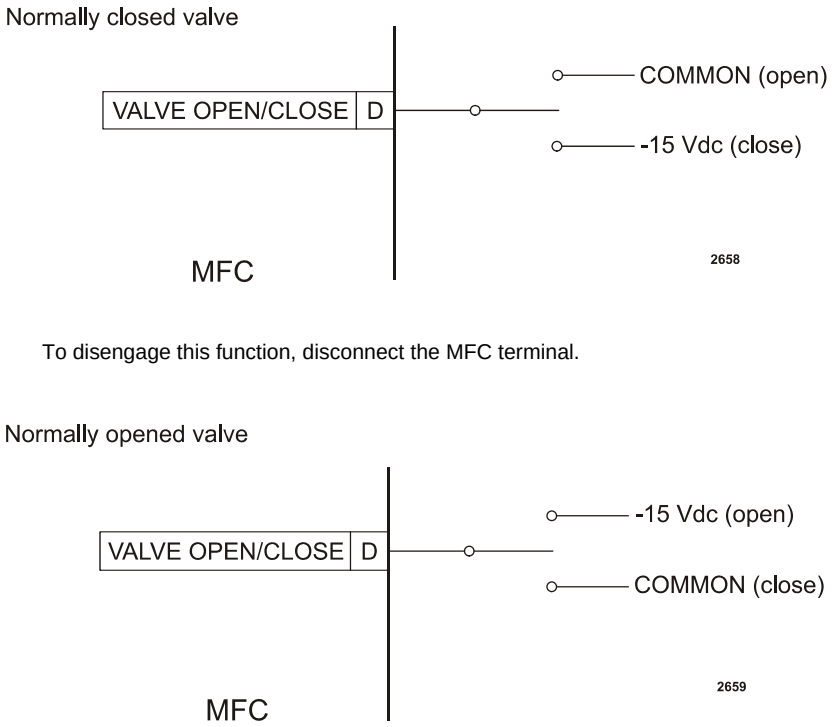


Figure 4-5. *Card edge purge function signals*

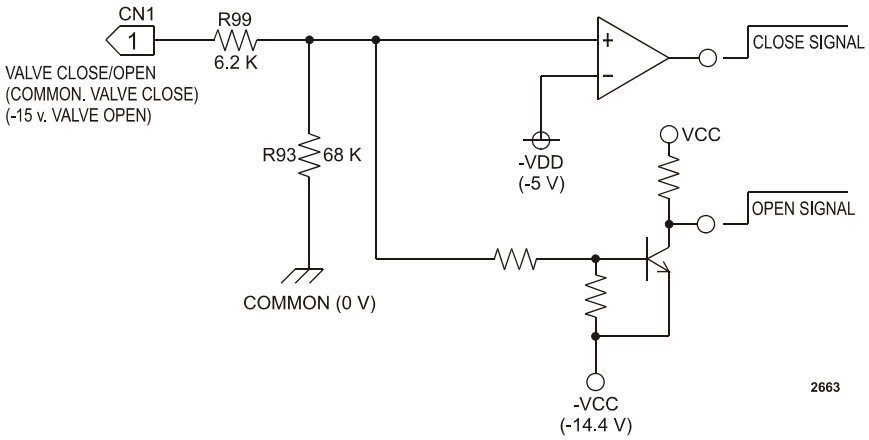


Figure 4-6. *Card edge normally open internal circuitry for purge function*

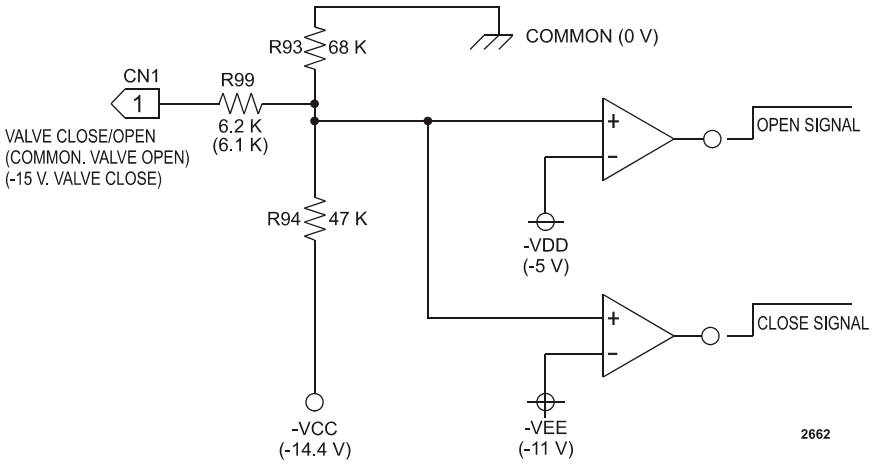
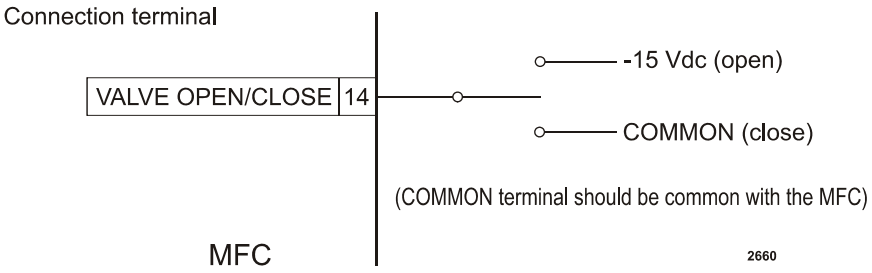


Figure 4-7. *Card edge normally closed internal circuitry for purge function*

HONDA 20-PIN PURGE FUNCTION SIGNALS

For the Honda 20-pin connector, normally open and normally closed valves use the same connection. However, the internal MFC circuitry is different for normally open and normally closed MFCs. Figure 4-8 shows the connection for the purge function. Figure 4-9 and Figure 4-10 show the internal circuitry for normally open and normally closed MFCs, respectively. (To check whether an MFC is normally closed or normally open, see "Model Numbers for this Manual" on page 1-1.)



To disengage this function, disconnect the MFC terminal.

Figure 4-8. *Honda 20-pin purge function connection*

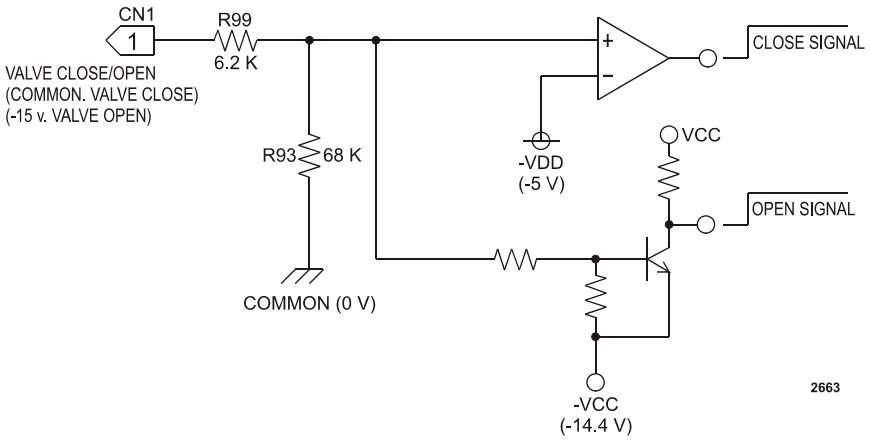


Figure 4-9. *Honda 20-pin normally open internal circuitry for purge function*

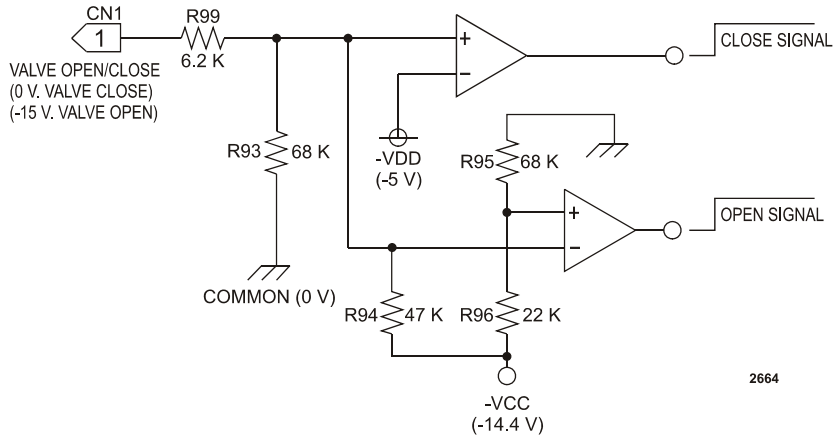
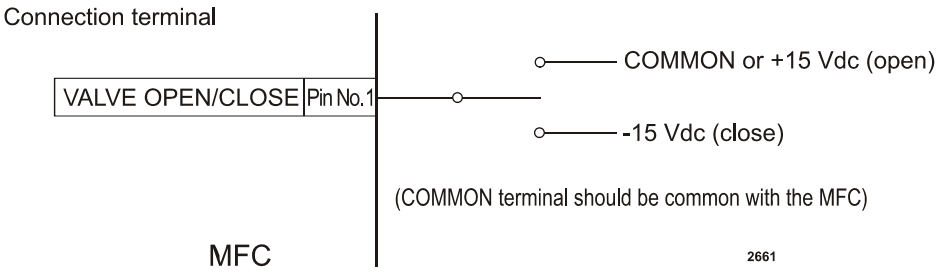


Figure 4-10. *Honda 20-pin normally closed internal circuitry for purge function*

SUBMINIATURE-D PURGE FUNCTION SIGNAL

For the 9-pin subminiature-D connector, Figure 4-11 shows the purge function connection. This connector is only available on normally closed MFCs. Figure 4-12 shows the internal circuitry for this connection.



To disengage this function, disconnect the MFC terminal.

Figure 4-11. *9-pin subminiature-D purge function connection*

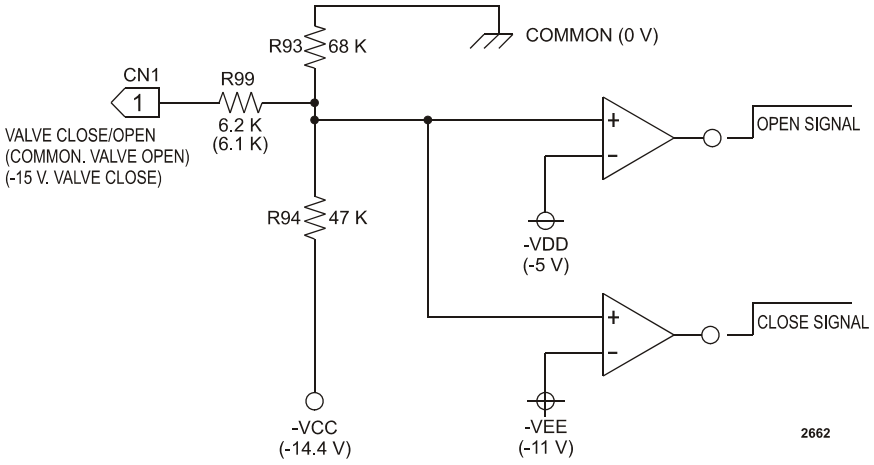


Figure 4-12. *9-pin subminiature-D internal circuitry for purge function*

Chapter 5

Troubleshooting and Global Customer Support

TROUBLESHOOTING

The following sections provide information on troubleshooting the MFC as well as AE Global Services contact information.

WARNING:
Hazardous voltages exist inside the mass flow controller (MFC). Do not remove the MFC cover.

Alarm Signals

Some MFCs provide alarm output under certain operating conditions. For more information, see "Alarm Output (Error Detection) Signals" on page 4-7.

Troubleshooting the Gas Flow

This section provides information on responding to the following flow-related problems:

- "No Gas Is Being Supplied" on page 5-2.
- "Set Point and Flow Output Do Not Match" on page 5-3.
- "Unstable Flow or Insufficient Output Exists" on page 5-4.

NO GAS IS BEING SUPPLIED

Use the following flow chart to troubleshoot if no gas is being supplied. If these procedures do not resolve the problem, contact AE Global Services (see "AE Global Services" on page 5-6).

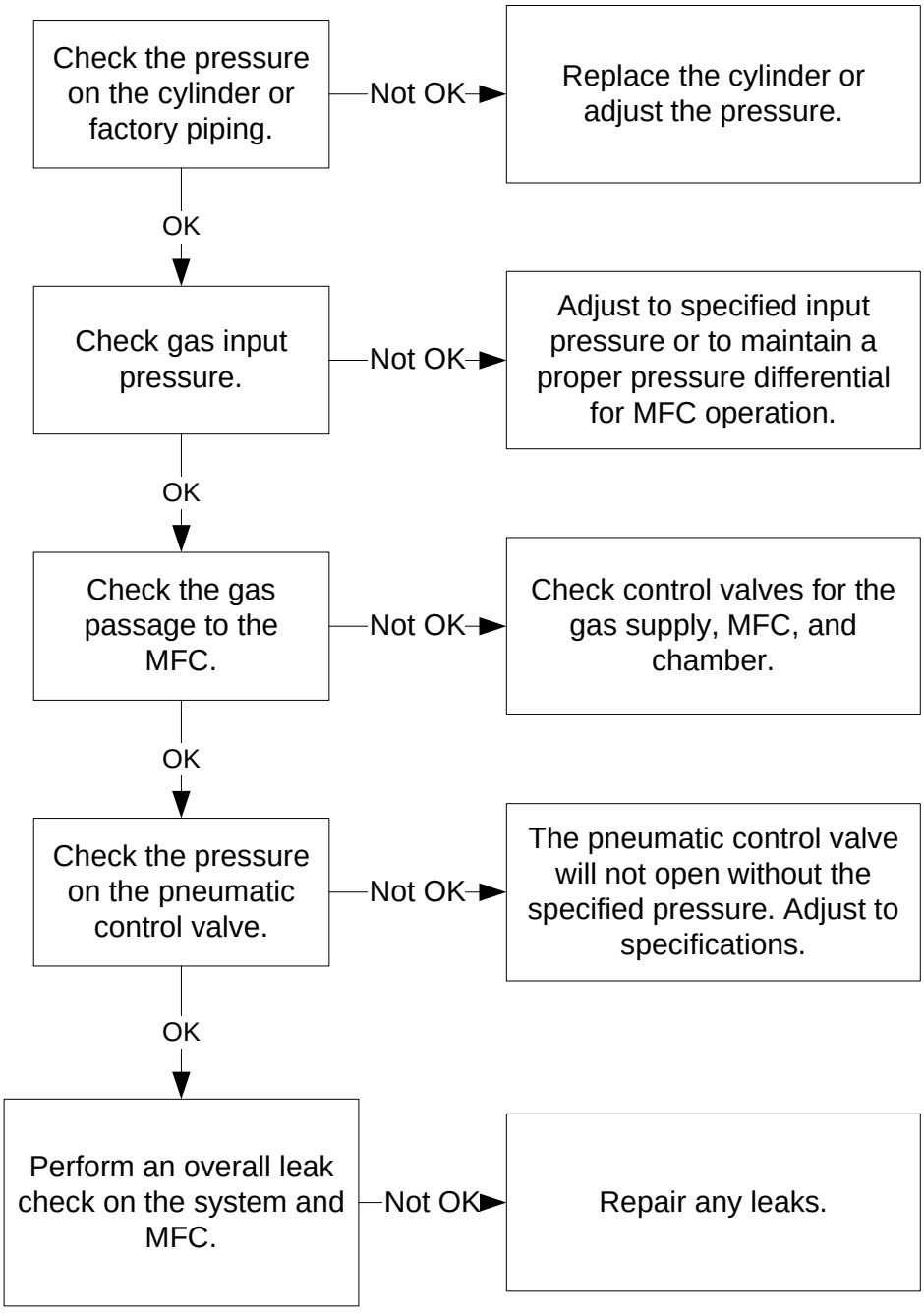

Check the pressure on the cylinder or factory piping.
Not OK
Replace the cylinder or adjust the pressure.
OK
Check gas input pressure.
Not OK
Adjust to specified input pressure or to maintain a proper pressure differential for MFC operation.
OK
Check the gas passage to the MFC.
Not OK
Check control valves for the gas supply, MFC, and chamber.
OK
Check the pressure on the pneumatic control valve.
Not OK
The pneumatic control valve will not open without the specified pressure. Adjust to specifications.
OK
Perform an overall leak check on the system and MFC.
Not OK
Repair any leaks.

Figure 5-1. *No Gas Is Being Supplied troubleshooting flow chart*

SET POINT AND FLOW OUTPUT DO NOT MATCH

Use the following procedure to troubleshoot if the set point and the flow output do not match. If these procedures do not resolve the problem, contact AE Global Services (see "AE Global Services" on page 5-6).

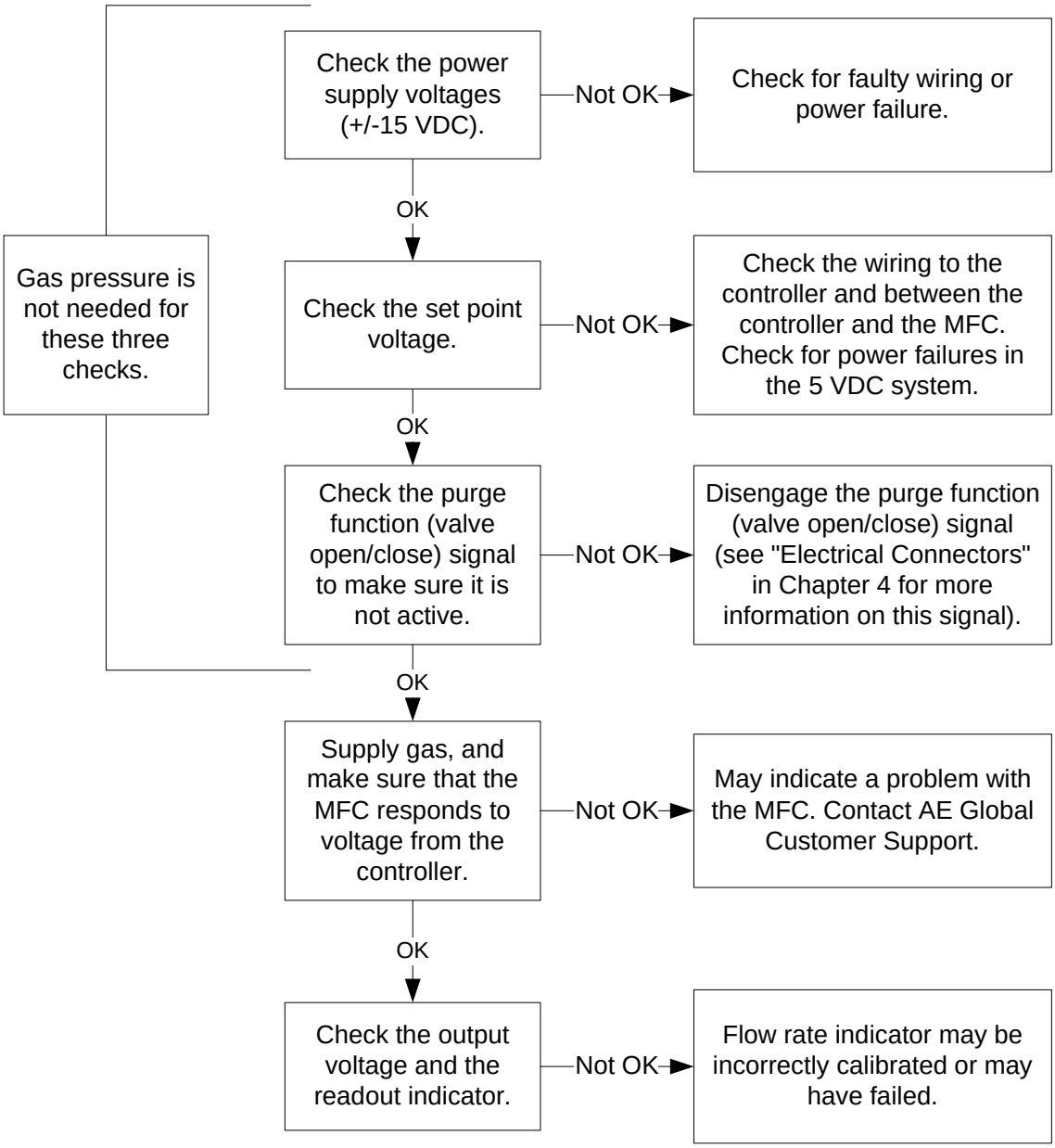

Check the power supply voltages (+/-15 VDC).
Not OK
Check for faulty wiring or power failure.
OK
Gas pressure is not needed for these three checks.
Check the set point voltage.
Not OK
Check the wiring to the controller and between the controller and the MFC. Check for power failures in the 5 VDC system.
OK
Check the purge function (valve open/close) signal to make sure it is not active.
Not OK
Disengage the purge function (valve open/close) signal (see "Electrical Connectors" in Chapter 4 for more information on this signal).
OK
Supply gas, and make sure that the MFC responds to voltage from the controller.
Not OK
May indicate a problem with the MFC. Contact AE Global Customer Support.
OK
Check the output voltage and the readout indicator.
Not OK
Flow rate indicator may be incorrectly calibrated or may have failed.

Figure 5-2. *Set Point and Flow Output Do Not Match troubleshooting flow chart*

UNSTABLE FLOW OR INSUFFICIENT OUTPUT EXISTS

Use the following procedure to troubleshoot unstable flow or insufficient output. If these procedures do not resolve the problem, contact AE Global Services (see “AE Global Services” on page 5-6).

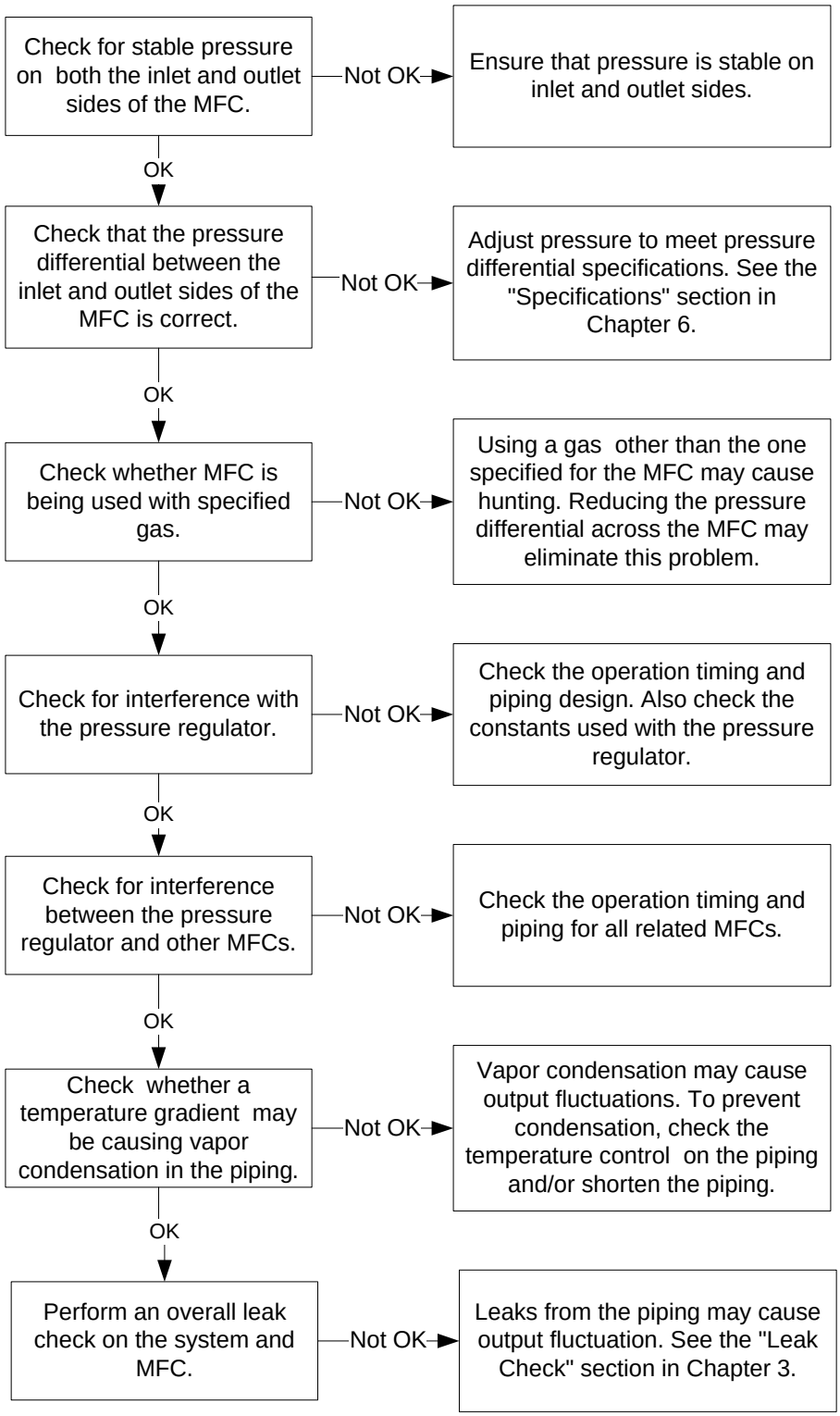

Check for stable pressure on both the inlet and outlet sides of the MFC.
Not OK
Ensure that pressure is stable on inlet and outlet sides.
OK
Check that the pressure differential between the inlet and outlet sides of the MFC is correct.
Not OK
Adjust pressure to meet pressure differential specifications. See the "Specifications" section in Chapter 6.
OK
Check whether MFC is being used with specified gas.
Not OK
Using a gas other than the one specified for the MFC may cause hunting. Reducing the pressure differential across the MFC may eliminate this problem.
OK
Check for interference with the pressure regulator.
Not OK
Check the operation timing and piping design. Also check the constants used with the pressure regulator.
OK
Check for interference between the pressure regulator and other MFCs.
Not OK
Check the operation timing and piping for all related MFCs.
OK
Check whether a temperature gradient may be causing vapor condensation in the piping.
Not OK
Vapor condensation may cause output fluctuations. To prevent condensation, check the temperature control on the piping and/or shorten the piping.
OK
Perform an overall leak check on the system and MFC.
Not OK
Leaks from the piping may cause output fluctuation. See the "Leak Check" section in Chapter 3.

Figure 5-3. *Unstable Flow or Insufficient Output Exists troubleshooting flow chart*

AE WORLD WIDE WEB SITE

For additional product information, consult Advanced Energy's World Wide Web site:

- http://www.advanced-energy.com

AE GLOBAL SERVICES

Please contact one of the following offices if you have questions.

Note: When calling AE Global Services, make sure to have the unit serial number and part number. These numbers are available on unit labels.

USA Support Locations

Table 5-1. *AE Global Services locations (USA)*

USA Offices	Contact Information
AE, World Headquarters 1625 Sharp Point Drive Fort Collins, CO 80525 USA *Note:* For returns and repairs, please call Global Services to get the correct shipping address.	Phone (24 hrs/day, 7 days/week): 800.446.9167 or 970.221.0108 FAX (M–F, 7:00 am – 5:30 pm MST): 970.407.5981 Email: technical.support@aei.com (We will respond to email by the next business day.) *Note:* For customers outside the US, please contact your local AE office.
Austin, Texas 8601 Cross Park Dr, Suite 100 Austin, TX 78754	Phone: • 800.MFC.AERA • 512.339.7100 FAX: 512. 339.8889:

Table 5-1. *AE Global Services locations (USA) (Continued)*

USA Offices	Contact Information
Dallas, Texas 13490 Floyd Rd #108 Dallas, TX 75243	Phone: 972.231.9333 FAX: 972.231.9446
San Jose, California 6389 San Ignacio Avenue San Jose, CA 95119	Phone: 408.281.7772 FAX: 408.281.7797

European Sales and Service Contacts

Table 5-2. *European sales and service offices*

European Offices	Contact Information
AE, GmbH Raiffeisenstrasse 32 70794 Filderstadt (Bonlanden) Germany	Phone: 49.711.779270 FAX: 49.711.7778700
Dressler HF-Technik GmbH Munsterau 168 52224 Stolberg-Vicht Germany	Phone: 49.2402.98810 FAX: 49.2402.98811
AE, United Kingdom Unit 5, Minton Place, Market Court, Victoria Road Bicester, Oxon OX26 6QB UK	Phone: 44.1869.320022 FAX: 44.1869.325004

Table 5-3. *European sales representative contacts*

European Offices	Contact Information
France Omicron Technologies ZA de Font Ratel 30 rue de l'Europe F-38640	Phone: 33(0) 476.99.22.60 FAX: 33(0) 476.99.22.66
Ireland Valley Products and Service, Ltd.	Phone: 353.(0).6.60.3504 FAX: 353.(0)6.68.9657
Italy MCU s.r.l.	Phone/FAX: 39.039.322351
Sweden Air Vac	Phone: 46.(0)40.41.1023 FAX: 46.(0)40.41.1318
Poland Vak-Pol	Phone: 48.(0)22.720.4511 FAX: 48.(0)22.720.3965
Slovakia Labway, spol. s.r.o.	Phone/FAX: 42.(0)7.396609

Middle East Sales and Service Contacts

Table 5-4. *Middle East sales and service contacts*

Middle Eastern Offices	Contact Information
Israel Scientific Products & Technology Ltd. PO Box 3629 49130 Petah Tikva	Phone: 972.(3).922.83.15 FAX: 972.(3).922.84.04

Asian Sales and Service Contacts

Table 5-5. *Pacific Rim sales and service offices*

Pacific Rim Offices	Contact Information
AE China 469 Huaxia Dong Road Zhang Jiang Town Shanghai, China 201203	Phone: 86-21-58579011 FAX: 86-21-58579003
AE Japan K.K. 2971-8 Ishikawa-cho Hachioji, Tokyo 192-0032 Japan	Phone: 81.426.45.8125 FAX: 81.426.44.0779
AE, Korea Ltd. (sales office) #613 Amigo Tower 358-2 Yatop-dong, Bundang-ku Sungam Si Kyunggi, 463-070 Korea **AE, Korea Ltd.** (service office) Gongduk Building, 4th floor 272-6 Seohyun-Dong, Bundang-Gu, Sungam Si Kyunggi, 463-050 Korea	Phone: 82.(0)31.622.0555 FAX: 82.(0)31.622.0556 Phone: 82.(0)31.705.2100 FAX: 82.(0)31.705.2766
Malaysia (Penang and Kuching service office) APP Systems Services Pte Ltd. 1048, Jalan Dato Ismail Hashim (Sungei Ara) 11900 Bayan Lepas, Penang, West Malaysia	Phone: 604.6467758
Singapore (sales and service office) APP Systems Services Pte Ltd. 11 Toh Guan Road East #03-01 APP Enterprise Building Singapore 608603	Phone: 65.64256611 FAX: 65.65606616
AE, Taiwan, Ltd. Hsin-Chu Branch 5F-12, No. 81, Shui Li Road Hsin-Chu, Taiwan	Phone: 886.(0)3.516.9301 FAX: 886.(0)3.516.9305

RETURNING MFCS FOR REPAIR

Before returning any product for repair and/or adjustment, ***first follow all troubleshooting procedures***. If, after following these procedures, you still have a problem, or if the procedure instructs you to, contact AE Global Services and discuss the problem with a representative. Be prepared to give the model number and serial number of the MFC, as well as the reason for the proposed return. This consultation call allows Global Services to determine whether the problem can be corrected in the field or if the MFC needs to be returned. Such technical consultation is always free of charge.

If you return an MFC without first getting authorization from Global Services and that MFC is found to be functional, you will be charged a re-test and calibration fee plus shipping charges.

If you have received authorization for return, see "Packing an MFC for Shipping" on page 5-10 for more information on packing the MFC for shipping.

To ensure years of dependable service, Advanced Energy® products are thoroughly tested and designed to be among the most reliable and highest quality systems available worldwide.

Packing an MFC for Shipping

Prior to shipping an MFC back to AE for repair or return, you must receive authorization from AE Global Services. For more information, see "Returning MFCs for Repair" on page 5-10.

Observe the following requirements when packing an MFC for shipment:

- Obtain a return authorization number from Global Services.
- Include the appropriate material safety data sheet (MSDS) information. Without this information, AE will return the MFC to you without repair.
- Follow your company procedures for purging and removal of an MFC.
- Seal the MFC end-fittings for shipping.
- Place the MFC in two plastic bags (double-bag packaging) for shipment. Be sure to vacuum seal each bag.

Pack the MFC with sufficient shock absorbent material to prevent damage to MFC's plastic bag from vibration or impact during shipment.

WARRANTY

All MFC warranties are void if the seal on the MFC cover is broken or removed.

Advanced Energy® (AE) products are warranted to be free from failures due to defects in material and workmanship for 12 months after they are shipped from the factory (please see warranty statement below for details).

In order to claim shipping or handling damage, you must inspect the delivered goods and report such damage to AE within 30 days of your receipt of the goods. Please note that failing to report any damage within this period is the same as acknowledging that the goods were received undamaged.

For a warranty claim to be valid, it must:

- Be made within the applicable warranty period
- Include the product serial number and a full description of the circumstances giving rise to the claim
- Have been assigned an RMA (return material authorization) number (see below) by AE Global Services

All warranty work will be performed at an authorized AE service center (see list of contacts at the beginning of this chapter). You are responsible for obtaining authorization (see details below) to return any defective MFCs, prepaying the freight costs, and ensuring that the MFCs are returned to an authorized AE service center. AE will return the repaired MFC (freight prepaid) to you by second-day air shipment (or ground carrier for local returns); repair parts and labor will be provided free of charge. Whoever ships the MFC (either you or AE) is responsible for properly packaging and adequately insuring the MFC. See “Packing an MFC for Shipping” on page 5-10 for more information on packing the MFC for shipping.

Authorized Returns

Before returning any product for repair and/or adjustment, call AE Global Services and discuss the problem with them. Be prepared to give them the model number and serial number of the MFC as well as the reason for the proposed return. This consultation call will allow Global Services to determine if the MFC must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

MFCs that are returned without authorization from AE Global Services and that are found to be functional will not be covered under the warranty (see warranty statement, below). That is, you will have to pay a retest and calibration fee, and all shipping charges.

Warranty Statement

Attention: All MFC warranties are void if the seal on the MFC cover is broken or removed.

Aera warrants that for a period of one year after shipment, products manufactured by Aera shall be free from defects in material and workmanship when installed, serviced, and operated with the specifications for which they were designed. Aera will replace or repair any equipment or parts returned provided that factory inspection shows that such defect developed under normal and proper use by the original user. Aera's liability under this warranty is limited to such replacement or repair and they shall not be held in any form of action for any incidental or consequential damages to property or person. The foregoing is in lieu of all other warranties, expressed or implied, including the warranties of merchantability and fitness for particular purpose. Representations and warranties by any person, including dealers and representatives of seller, which are inconsistent or in conflict with the terms of this warranty (including but not limited to limitations of liability as set forth above), shall not be binding unless produced in writing and approved by an authorized representative of Aera.

Chapter 6

Specifications and Reference Information

This chapter contains information on the specifications of models covered by this manual, the dimensions of each model, and reference information (including information about calibration and labeling).

MODEL SPECIFICATIONS

The following sections list the specifications for the MFC models covered in this manual.

Specifications for Model FC-770 MFCs

The following table lists specifications for the FC-770 MFCs.

Table 6-1. *Specifications for FC-770 series MFCs*

Specification	FC-770A	FC-770AC
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 2 seconds	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-7} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA, Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, KM-45, Viton, or Chloroprene rubber	
Standard fitting	1/4″ VCR, 1/4″ SW, 1/4″ VCO	
Mounting position	Any direction	
Weight	0.9 kg (2.0 lb)	
Options	Current output (0 mA to 2.5 mA), 1/4″ MCG fitting	
Standard equipment	Error detection function	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-771 MFCs

The following table lists specifications for the FC-771 MFCs.

Table 6-2. *Specifications for FC-771 series MFCs*

Specification	FC-771A	FC-771AC
Full-scale range (N_2 equivalent)	6 slm to 20 slm	6 slm to 50 slm
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 2 seconds	
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale (over 20 slm, maximum, ±2% of full scale)	
Linearity	Under 20 slm, maximum ±0.5% of full scale (over 20 slm, maximum, ±1% of full scale)	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-7} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D) at ≥20 slm 98 to 275 kPa(D); 14 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA, Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, KM-45, Viton, or Chloroprene rubber	
Standard fitting	1/4″ VCR, 1/4″ SW, 1/4″ VCO, 3/8″ VCR, 3/8″SW, 3/8″ VCO	
Mounting position	Any direction	
Weight	0.9 kg (2.0 lb)	
Options	Current output (0 mA to 2.5 mA), 1/4″ MCG fitting	
Standard equipment	Error detection function	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-772 MFCs

The following table lists specifications for the FC-772 MFCs.

Table 6-3. *Specifications for FC-772 series MFCs*

Specification	FC-772	FC-772C
Full-scale range (N_2 equivalent)	35 slm to 150 slm	
Valve type	Normally open	Normally closed
Response time	Within 3 s (typical) ±2% at 50% to 100% and 100% to 50%	
Accuracy[Note 1]	Maximum ±2% of full scale	
Linearity	Maximum ±1% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-7} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	147 to 275 kPa(D); 21 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 220 mA	
Power consumption	Maximum 3.7 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, KM-45, Viton, or Chloroprene rubber	
Standard fitting	1/4″ VCR, 3/8″ VCR, 1/4″ SW, 3/8″ SW	
Mounting position	Any direction	
Weight	2.6 kg (5.7 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, 1/4″ VCO fitting, 3/8″ VCO fitting, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—PTFE may be required, depending on your intended flow rate range.

Specifications for Model FC-780HT MFCs

The following table lists specifications for the FC-780HT MFCs.

Table 6-4. *Specifications for FC-780HT series MFCs*

Specification	FC-780HT	FC-780CHT
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time[Note 4]	Maximum ±2% of full scale, within 2 s	Maximum ±2% of full scale, within 1 s
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	MFC unit: 50ºC to 80ºC (122ºC to 176ºF) PCB unit: 5ºC to 50ºC (41ºF to 122ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, Ni, KM-45	
Standard fitting	1/4″ VCR, 1/4″ SW	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	Either current output (0 mA to 2.5 mA) or error detection function, 1/4″ MCG fitting	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—The range or response times may vary depending on the vapor or gas properties.

Specifications for Model FC-780 MFCs

The following table lists specifications for the FC-780 MFCs.

Table 6-5. *Specifications for FC-780 series MFCs*

Specification	FC-780	FC-780C
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	29.4 to 294 kPa(D); 4 to 43 psi(D)
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, Ni, KM-45	
Standard fitting	1/4″ VCR, 1/4″ SW, 1/4″ MCG, 1/4″ S-JSK	1/4″ VCR, 1/4″ SW,
Mounting position	Any direction	
Weight	1.2 kg (2.6 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment, 1/4″ VCO fitting

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-780X MFCs

The following table lists specifications for the FC-780X MFCs.

Table 6-6. *Specifications for FC-780X series MFCs*

Specification	FC-780X	FC-780XC
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	29.4 to 294 kPa(D); 4 to 43 psi(D)
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, KM-45	
Standard fitting	1/4″ VCR, 1/4″ SW,	
Mounting position	Any direction	
Weight	1.2 kg (2.6 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-781HT MFCs

The following table lists specifications for the FC-781HT MFCs.

Table 6-7. *Specifications for FC-781HT series MFCs*

Specification	FC-781HT	FC-781CHT
Full-scale range (N_2 equivalent)	6 slm to 30 slm	6 slm to 20 slm
Valve type	Normally open	Normally closed
Response time[Note 3]	Maximum ±2% of full scale, within 2 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	MFC unit: 50ºC to 80ºC (122ºC to 176ºF) PCB unit: 5ºC to 50ºC (41ºF to 122ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material[Note 4]	SUS316, SUS316L, PTFE, Ni, KM-45, Viton, Chloroprene rubber	
Standard fitting	1/4″ VCR, SW, 3/8″ VCR	
Mounting position	Any direction	
Weight	1.8 kg (4.0 lb)	
Options	Either current output (0 mA to 2.5 mA) or error detection function, 1/4″ MCG fitting	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—The range or response times may vary depending on the vapor or gas properties.
Note 4—Use of Viton or Chloroprene rubber may be required depending on the intended flow rate range.

Specifications for Model FC-781 MFCs

The following table lists specifications for the FC-781 MFCs.

Table 6-8. *Specifications for FC-781 series MFCs*

Specification	FC-781	FC-781C
Full-scale range (N_2 equivalent)	6 slm to 20 slm	6 slm to 50 slm
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	Maximum ±2% of full scale, within 2 s
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale (over 20 slm, maximum, ±2% of full scale)	
Linearity	Under 20 slm, maximum ±0.5% of full scale (over 20 slm, maximum, ±1% of full scale)	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D)	69 to 294 kPa(D); 10 to 43 psi(D) ≥20 slm: 98 to 294 kPa(D); 14 to 43 psi(D)
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, Ni, KM-45	
Standard fitting	1/4″ VCR	
Mounting position	Any direction	
Weight	1.5 kg (3.3 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—Use of Viton or Chloroprene rubber may be required depending on the intended flow rate range.

Specifications for Model FC-782 MFCs

The following table lists specifications for the FC-782 MFCs.

Table 6-9. *Specifications for FC-782 series MFCs*

Specification	FC-782	FC-782C
Full-scale range (N_2 equivalent)	35 slm to 150 slm	
Valve type	Normally open	Normally closed
Response time	Within 3 s (typical), ±2%	
Accuracy[Note 1]	Maximum ±2% of full scale	
Linearity	Maximum ±1% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	147 to 275 kPa(D); 21 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 220 mA	
Power consumption	Maximum 3.7 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, KM-45	
Standard fitting[Note 4]	1/4″ VCR, 3/8″ VCR, 1/4″ UJR, 3/8″ UJR	
Mounting position	Any direction	
Weight	2.8 kg (6.2 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—Use of PTFE, Viton, or Chloroprene rubber may be required depending on the intended flow rate range.
Note 4—3/8″ VCR or 3/8″ UJR fitting is required if 100 slm or more is derived from full-scale range N_2 equivalent.

Specifications for Model FC-785 MFCs

The following table lists specifications for the FC-785 MFCs.

Table 6-10. *Specifications for FC-785 series MFCs*

Specification	FC-785	FC-785C
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, Ni, KM-45	
Standard fitting	Equivalent to 1/4″ VCR	
Mounting position	Any direction	
Weight	1.0 kg (2.2 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, electropolishing	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-785T-B MFCs

The following table lists specifications for the FC-785T-B MFCs.

Table 6-11. *Specifications for FC-785T-B series MFCs*

Specification	FC-785T-B	FC-785CT-B
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, Ni, KM-45	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-785X-B MFC

The following table lists specifications for the FC-785X-B MFC.

Table 6-12. *Specifications for model FC-785X-B MFC*

Specification	FC-785XC-B
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm
Valve type	Normally closed
Response time	Maximum ±2% of full scale, within 1 s
Accuracy[Note 1]	Maximum ±1% of full scale
Linearity	Maximum ±0.5% of full scale
Repeatability	Maximum at ±0.2% of full scale
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]
Flow rate control range	2% to 100%
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)
Flow rate setting and output signal	0 VDC to 5.0 VDC
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA
Power consumption	Maximum 3.1 W
Gas-wetted surface material	SUS316, SUS316L, PTFE, KM-45
Mounting position	Any direction
Weight	1.0 kg (2.2 lb)
Options	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-785Y-B MFCs

The following table lists specifications for the FC-785Y-B MFCs.

Table 6-13. *Specifications for FC-785Y-B series MFCs*

Specification	FC-785Y-B	FC-785CY-B
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, Ni, KM-45	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	Current output (0 mA to 2.5 mA), error detection, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-786 MFCs

The following table lists specifications for the FC-786 MFCs.

Table 6-14. *Specifications for FC-786 series MFCs*

Specification	FC-786	FC-786C
Full-scale range (N_2 equivalent)	6 slm to 30 slm	6 slm to 50 slm
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale (over 20 slm, maximum, ±2% of full scale)	
Linearity	Under 20 slm, maximum ±0.5% of full scale (over 20 slm, maximum ±1% of full scale)	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D) ≥20 slm: 147 to 275 kPa(D); 21 to 40 psi(D)	69 to 275 kPa(D); 10 to 40 psi(D) ≥20 slm: 98 to 275 kPa(D); 14 to 40 psi(D)
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, Ni, KM-45	
Standard fitting	Equivalent to 1/4″ VCR	
Mounting position	Any direction	
Weight	1.0 kg (2.2 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, electropolishing	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—Use of Viton or Chloroprene rubber may be required depending on the intended flow rate range.

Specifications for Model FC-786T-B MFCs

The following table lists specifications for the FC-786T-B MFCs.

Table 6-15. *Specifications for FC-786T-B series MFCs*

Specification	FC-786T-B	FC-786CT-B
Full-scale range (N_2 equivalent)	6 slm to 30 slm	6 slm to 50 slm
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale; over 20 slm, maximum ±2% of full scale	
Linearity	Under 20 slm, maximum ±0.5% of full scale; over 20 slm, maximum ±1% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D) ≥20 slm: 147 to 275 kPa(D); 21 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, Ni, KM-45	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—Use of Viton or Chloroprene rubber may be required depending on the intended flow rate range.

Specifications for Model FC-786Y-B MFCs

The following table lists specifications for the FC-786Y-B MFCs.

Table 6-16. *Specifications for FC-786Y-B series MFCs*

Specification	FC-786Y-B	FC-786CY-B
Full-scale range (N_2 equivalent)	6 slm to 30 slm	6 slm to 50 slm
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale; over 20 slm, maximum ±2% of full scale)	
Linearity	Under 20 slm, maximum ±0.5% of full scale; over 20 slm, maximum ±1% of full scale)	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D) ≥20 slm: 147 to 275 kPa(D); 21 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, Ni, KM-45, Viton, Chloroprene rubber	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—Use of Viton or Chloroprene rubber may be required depending on the intended flow rate range.

Specifications for Model FC-790 MFCs

The following table lists specifications for the FC-790 MFCs.

Table 6-17. *Specifications for FC-790 series MFCs*

Specification		FC-790	FC-790C
Full-scale range (N_2 equivalent)		10 sccm to 5000 sccm	
Valve type		Normally open	Normally closed
Response time		Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]		Maximum ±1% of full scale	
Linearity		Maximum ±0.5% of full scale	
Repeatability		Maximum at ±0.2% of full scale	
External leak rate		Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range		2% to 100%	
Operating pressure range	In	49 to 275 kPa(G); 7 to 40 psi(G)	
	Out	Atmosphere to vacuum 0 kPa(G), 0 kPa(A)	
Proof pressure[Note 2]		981 kPa(G); 142 psi(G)	
Operating temperature		5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal		0 VDC to 5.0 VDC	
Supply power		Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption		Maximum 3.1 W	
Gas-wetted surface material		SUS316, SUS316L, PCTFE	
Standard fitting		Equivalent to 1/4″ VCR	
Mounting position		Any direction	
Weight		1.1 kg (2.4 lb)	
Options		Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-791 MFCs

The following table lists specifications for the FC-791 MFCs.

Table 6-18. *Specifications for FC-791 series MFCs*

Specification		FC-791	FC-791C
Full-scale range (N_2 equivalent)		6 slm to 30 slm	6 slm to 50 slm
Valve type		Normally open	Normally closed
Response time		Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]		Maximum ±1% of full scale	
Linearity		Maximum ±0.5% of full scale	
Repeatability		Maximum at ±0.2% of full scale	
External leak rate		Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range		2% to 100%	
Operating pressure range	In	69 to 275 kPa(G); 10 to 40 psi(G)[Note 3]	69 to 275 kPa(G); 10 to 40 psi(G) [Note 4]
	Out	Atmosphere to vacuum 0 kPa(G), 0 kPa(A)	
Proof pressure[Note 2]		981 kPa(G); 142 psi(G)	
Operating temperature		5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal		0 VDC to 5.0 VDC	
Supply power		Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption		Maximum 3.1 W	
Gas-wetted surface material		SUS316, SUS316L, PCTFE	
Standard fitting		Equivalent to 1/4″ VCR	
Mounting position		Any direction	
Weight		1.2 kg (2.4 lb)	
Options		Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—98 to 275 kPa(G) [14 to 40 psi(G)] when full-scale (N_2 equivalent) is over 20 slm and less than 30 slm. 147 to 275 kPa(G) [21 to 40 psi(G)] when full-scale (N_2 equivalent) is 30 slm.
Note 4—98 to 275 kPa(G) [14 to 40 psi(G)] when full-scale (N_2 equivalent) is over 20 slm and less than 30 slm. 147 to 275 kPa(G) [21 to 40 psi(G)] when full-scale (N_2 equivalent) is from 30 slm to 50 slm.

Specifications for Model FC-795 MFCs

The following table lists specifications for the FC-795 MFCs.

Table 6-19. *Specifications for FC-795 series MFCs*

Specification		FC-795	FC-795C
Full-scale range (N_2 equivalent)		10 sccm to 5000 sccm	
Valve type		Normally open	Normally closed
Response time		Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]		Maximum ±1% of full scale	
Linearity		Maximum ±0.5% of full scale	
Repeatability		Maximum at ±0.2% of full scale	
External leak rate		Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range		2% to 100%	
Operating pressure range	In	49 to 275 kPa(G); 7 to 40 psi(G)	
	Out	Atmosphere to vacuum 0 kPa(G), 0 kPa(A)	
Proof pressure[Note 2]		981 kPa(G); 142 psi(G)	
Operating temperature		5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal		0 VDC to 5.0 VDC	
Supply power		Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption		Maximum 3.1 W	
Gas-wetted surface material		SUS316, SUS316L, PCTFE	
Standard fitting		Equivalent to 1/4″ VCR	
Mounting position		Any direction	
Weight		0.9 kg (2.0 lb)	
Options		Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-795T-B MFCs

The following table lists specifications for the FC-795T-B MFCs.

Table 6-20. *Specifications for FC-795T-B series MFCs*

Specification		FC-795T-B	FC-795CT-B
Full-scale range (N_2 equivalent)		10 sccm to 5000 sccm	
Valve type		Normally open	Normally closed
Response time		Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]		Maximum ±1% of full scale	
Linearity		Maximum ±0.5% of full scale	
Repeatability		Maximum at ±0.2% of full scale	
External leak rate		Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range		2% to 100%	
Operating pressure range	In	49 to 275 kPa(G); 7 to 40 psi(G)	
	Out	Atmosphere to vacuum—0 kPa(G), 0 kPa(A)	
Proof pressure[Note 2]		981 kPa(G); 142 psi(G)	
Operating temperature		5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal		0 VDC to 5.0 VDC	
Supply power		Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption		Maximum 3.1 W	
Gas-wetted surface material		SUS316, SUS316L, PCTFE, PTFE	
Mounting position		Any direction	
Weight		1.2 kg (2.6 lb)	
Options		Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-796 MFCs

The following table lists specifications for the FC-796 MFCs.

Table 6-21. *Specifications for FC-796 series MFCs*

Specification		FC-796	FC-796C
Full-scale range (N_2 equivalent)		6 slm to 30 slm	6 slm to 50 slm
Valve type		Normally open	Normally closed
Response time		Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]		Maximum ±1% of full scale	
Linearity		Maximum ±0.5% of full scale	
Repeatability		Maximum at ±0.2% of full scale	
External leak rate		Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range		2% to 100%	
Operating pressure range	In	69 to 275 kPa(G); 10 to 40 psi(G)[Note 3]	69 to 275 kPa(G); 10 to 40 psi(G) [Note 4]
	Out	Atmosphere to vacuum 0 kPa(G), 0 kPa(A)	
Proof pressure[Note 2]		981 kPa(G); 142 psi(G)	
Operating temperature		5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal		0 VDC to 5.0 VDC	
Supply power		Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption		Maximum 3.1 W	
Gas-wetted surface material		SUS316, SUS316L, PCTFE	
Standard fitting		Equivalent to 1/4″ VCR	
Mounting position		Any direction	
Weight		1 kg (2.2 lb)	
Options		Current output (0 mA to 2.5 mA), error detection function, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—98 to 275 kPa(G) [14 to 40 psi(G)] when the full-scale (N_2 equivalent) is over 10 slm and less than 30 slm. 147 to 275 kPa(G) [21 to 40 psi(G)] when the full-scale (N_2 equivalent) is 30 slm.
Note 4—98 to 275 kPa(G) [14 to 40 psi(G)] when the full-scale (N_2 equivalent) is over 10 slm and less than 30 slm. 147 kPa(G) to 275 kPa(G)) when the full-scale (N_2 equivalent) is from 30 slm to 50 slm.

Specifications for Model FC-7700 MFCs

The following table lists specifications for the FC-7700 MFCs.

Table 6-22. *Specifications for FC-7700 series MFCs*

Specification	FC-7700	FC-7700C	FC-7700CD	FC-7700CU
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm			
Valve type	Normally open	Normally closed		
Response time	Maximum ±2% of full scale, within 2 seconds			
Accuracy[Note 1]	Maximum ±1% of full scale			
Linearity	Maximum ±0.5% of full scale			
Repeatability	Maximum at ±0.2% of full scale			
External leak rate	Maximum 1 x 10^{-7} [Pa*m^3/sec(He)]			
Flow rate control range	5% to 100%			2% to 100%
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)			
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)			
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)			
Flow rate setting and output signal	0 VDC to 5.0 VDC			
Supply power	Minimum +15 VDC ±2% 25 mA, Minimum -15 VDC ±2% 180 mA			
Power consumption	Maximum 3.1 W			
Gas-wetted surface material	SUS316, SUS316L, KM-45, Viton, or Chloroprene rubber			
Standard fitting	1/4″ VCR, 1/4″ SW, 1/4″ VCO			
Mounting position	Any direction			
Weight	0.9 kg (2.0 lb)			
Options	1/4″ MCG fitting			

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-7710 MFCs

The following table lists specifications for the FC-7710 MFCs.

Table 6-23. *Specifications for FC-7710 series MFCs*

Specification	FC-7710	FC-7710C	FC-7710CD	FC-7710CU
Full-scale range (N_2 equivalent)	6 slm to 20 slm	6 slm to 50 slm	6 slm to 30 slm	
Valve type	Normally open	Normally closed		
Response time	Maximum ±2% of full scale, within 2 seconds			
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale; over 20 slm, maximum of ±2% of full scale			
Linearity	Under 20 slm, maximum ±0.5% of full scale; over 20 slm, maximum of ±1% of full scale			
Repeatability	Maximum at ±0.2% of full scale			
External leak rate	Maximum 1 x 10^{-7} [Pa*m^3/sec(He)]			
Flow rate control range	5% to 100%			2% to 100%
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D)			
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)			
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)			
Flow rate setting and output signal	0 VDC to 5.0 VDC			
Supply power	Minimum +15 VDC ±2% 25 mA, Minimum -15 VDC ±2% 180 mA			
Power consumption	Maximum 3.1 W			
Gas-wetted surface material	SUS316, SUS316L, KM-45, Viton, or Chloroprene rubber			
Standard fitting	1/4″ VCR, 1/4″ SW		Equivalent to 1/4″ VCR, 1/4″ SW	
Mounting position	Any direction			
Weight	0.9 kg (2.0 lb)			

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-7720 MFCs

The following table lists specifications for the FC-7720 MFCs.

Table 6-24. *Specifications for FC-7720 series MFCs*

Specification	FC-7720	FC-7720C, FC-7720CD
Full-scale range (N_2 equivalent)	35 slm to 150 slm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 4 s	
Accuracy[Note 1]	Maximum ±2% of full scale	
Linearity	Maximum ±1% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-7} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	147 to 275 kPa(D); 21 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 220 mA	
Power consumption	Maximum 3.7 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, KM-45, Viton, or Chloroprene rubber	
Standard fitting[Note 4]	1/4″ VCR, 1/4″ SW, 3/8″ VCR, 3/8″ SW	
Mounting position	Any direction	
Weight	2.3 kg (5.1 lb)	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—PTFE may be required, depending on the intended flow rate range.
Note 4—3/8″ VCR fitting or 3/8″ UJR fitting is required if 100 slm or more is derived from full-scale range (N_2 equivalent).

Specifications for Model FC-7800 MFCs

The following table lists specifications for the FC-7800 MFCs.

Table 6-25. *Specifications for FC-7800 series MFCs*

Specification	FC-7800	FC-7800C	FC-7800CD	FC-7800CU
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm			
Valve type	Normally open	Normally closed		
Response time	Maximum ±2% of full scale, within 1 s			
Accuracy[Note 1]	Maximum ±1% of full scale			
Linearity	Maximum ±0.5% of full scale			
Repeatability	Maximum at ±0.2% of full scale			
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]			
Flow rate control range	5% to 100%			
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)			
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)			
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)			
Flow rate setting and output signal	0 VDC to 5.0 VDC			
Supply power	Minimum +15 VDC ±2% 25 mA, Minimum -15 VDC ±2% 180 mA			
Power consumption	Maximum 3.1 W			
Gas-wetted surface material	SUS316, SUS316L, PTFE, Ni, KM-45			
Standard fitting	1/4″ VCR, 1/4″ SW			1/4″ VCR
Mounting position	Any direction			
Weight	1.2 kg (2.6 lb)			

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-7810 MFCs

The following table lists specifications for the FC-7810 MFCs.

Table 6-26. *Specifications for FC-7810 series MFCs*

Specification	FC-7810	FC-7810C	FC-7810CD, FC-7810CU
Full-scale range (N_2 equivalent)	6 slm to 30 slm	6 slm to 50 slm	6 slm to 30 slm
Valve type	Normally open	Normally closed	
Response time	Maximum ±2% of full scale, within 2 seconds		
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale; over 20 slm, maximum of ±2% of full scale		
Linearity	Under 20 slm, maximum ±0.5% of full scale; over 20 slm, maximum of ±1% of full scale		
Repeatability	Maximum at ±0.2% of full scale		
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]		
Flow rate control range	5% to 100%		
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D) ≥ 20 slm: 147 to 275 kPa(D); 21to 40 psi(D)	69 to 275 kPa(D); 10 to 40 psi(D ≥20 slm: 98 to 294 kPa(D); 14 to 43 psi(D)	69 to 275 kPa(D); 10 to 40 psi(D ≥20 slm: 98 to 275 kPa(D);14 to 40 psi(D)
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)		
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)		
Flow rate setting and output signal	0 VDC to 5.0 VDC		
Supply power	Minimum +15 VDC ±2% 25 mA, Minimum -15 VDC ±2% 180 mA		
Power consumption	Maximum 3.1 W		
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, Ni, KM-45, Viton, Chloroprene rubber		
Standard fitting	1/4″ VCR	1/4″ VCR, 1/4″ SW	Equivalent to 1/4″ VCR
Mounting position	Any direction		
Weight	1.5 kg (3.3 lb)		

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—Use of Viton or Chloroprene rubber may be required, depending on the intended flow rate range

Specifications for Model FC-7820 MFCs

The following table lists specifications for the FC-7820 MFCs.

Table 6-27. *Specifications for FC-7820 series MFCs*

Specification	FC-7820	FC-7820C
Full-scale range (N_2 equivalent)	35 slm to 150 slm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 4 s	
Accuracy[Note 1]	Maximum ±2% of full scale	
Linearity	Maximum ±1% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	147 to 275 kPa(D); 21 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 220 mA	
Power consumption	Maximum 3.7 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, KM-45	
Standard fitting[Note 4]	1/4″ VCR, 3/8″ VCR	
Mounting position	Any direction	
Weight	2.8 kg (6.2 lb)	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—PTFE, Viton, or chloroprene rubber may be required, depending on the intended flow rate range.
Note 4—3/8″ VCR fitting or 3/8″ UJR fitting is required if 100 slm or more is derived from full-scale range (N_2 equivalent).

Specifications for Model FC-7850Y-B MFCs

The following table lists specifications for the FC-7850Y-B MFCs.

Table 6-28. *Specifications for FC-7850Y-B series MFCs*

Specification	FC-7850Y-B	FC-7850CY-B
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 2 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	5% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, KM-45	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-7810 MFCs

The following table lists specifications for the FC-7810 MFCs.

Table 6-29. *Specifications for FC-7810 series MFCs*

Specification	FC-7810	FC-7810C	FC-7810CD, FC-7810CU
Full-scale range (N_2 equivalent)	6 slm to 30 slm	6 slm to 50 slm	6 slm to 30 slm
Valve type	Normally open	Normally closed	
Response time	Maximum ±2% of full scale, within 2 seconds		
Accuracy[Note 1]	Under 20 slm, maximum ±1% of full scale; over 20 slm, maximum of ±2% of full scale		
Linearity	Under 20 slm, maximum ±0.5% of full scale; over 20 slm, maximum of ±1% of full scale		
Repeatability	Maximum at ±0.2% of full scale		
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]		
Flow rate control range	5% to 100%		
Operating pressure range	69 to 275 kPa(D); 10 to 40 psi(D) ≥ 20 slm: 147 to 275 kPa(D); 21to 40 psi(D)	69 to 275 kPa(D); 10 to 40 psi(D ≥20 slm: 98 to 294 kPa(D); 14 to 43 psi(D)	69 to 275 kPa(D); 10 to 40 psi(D ≥20 slm: 98 to 275 kPa(D);14 to 40 psi(D)
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)		
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)		
Flow rate setting and output signal	0 VDC to 5.0 VDC		
Supply power	Minimum +15 VDC ±2% 25 mA, Minimum -15 VDC ±2% 180 mA		
Power consumption	Maximum 3.1 W		
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, Ni, KM-45, Viton, Chloroprene rubber		
Standard fitting	1/4″ VCR	1/4″ VCR, 1/4″ SW	Equivalent to 1/4″ VCR
Mounting position	Any direction		
Weight	1.5 kg (3.3 lb)		

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—Use of Viton or Chloroprene rubber may be required, depending on the intended flow rate range

Specifications for Model FC-7820 MFCs

The following table lists specifications for the FC-7820 MFCs.

Table 6-30. *Specifications for FC-7820 series MFCs*

Specification	FC-7820	FC-7820C
Full-scale range (N_2 equivalent)	35 slm to 150 slm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 4 s	
Accuracy[Note 1]	Maximum ±2% of full scale	
Linearity	Maximum ±1% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	147 to 275 kPa(D); 21 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 220 mA	
Power consumption	Maximum 3.7 W	
Gas-wetted surface material[Note 3]	SUS316, SUS316L, PTFE, KM-45	
Standard fitting[Note 4]	1/4″ VCR, 3/8″ VCR	
Mounting position	Any direction	
Weight	2.8 kg (6.2 lb)	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.
Note 3—PTFE, Viton, or chloroprene rubber may be required, depending on the intended flow rate range.
Note 4—3/8″ VCR fitting or 3/8″ UJR fitting is required if 100 slm or more is derived from full-scale range (N_2 equivalent).

Specifications for Model FC-7850Y-B MFCs

The following table lists specifications for the FC-7850Y-B MFCs.

Table 6-31. *Specifications for FC-7850Y-B series MFCs*

Specification	FC-7850Y-B	FC-7850CY-B
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 2 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	5% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, KM-45	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

Specifications for Model FC-785Y-B MFCs

The following table lists specifications for the FC-785Y-B MFCs.

Table 6-32. *Specifications for FC-785Y-B series MFCs*

Specification	FC-785Y-B	FC-785CY-B
Full-scale range (N_2 equivalent)	10 sccm to 5000 sccm	
Valve type	Normally open	Normally closed
Response time	Maximum ±2% of full scale, within 1 s	
Accuracy[Note 1]	Maximum ±1% of full scale	
Linearity	Maximum ±0.5% of full scale	
Repeatability	Maximum at ±0.2% of full scale	
External leak rate	Maximum 1 x 10^{-11} [Pa*m^3/sec(He)]	
Flow rate control range	2% to 100%	
Operating pressure range	49 to 275 kPa(D); 7 to 40 psi(D)	
Proof pressure[Note 2]	981 kPa(G); 142 psi(G)	
Operating temperature	5ºC to 45ºC (41ºF to 113ºF)	
Flow rate setting and output signal	0 VDC to 5.0 VDC	
Supply power	Minimum +15 VDC ±2% 25 mA Minimum -15 VDC ±2% 180 mA	
Power consumption	Maximum 3.1 W	
Gas-wetted surface material	SUS316, SUS316L, PTFE, Ni, KM-45	
Mounting position	Any direction	
Weight	1.3 kg (2.9 lb)	
Options	Current output (0 mA to 2.5 mA), error detection, TC surface treatment	

Note 1—Accuracy ensures that the calibration gas equivalent flow is ±1% of full scale when 22 ± 3ºC in temperature is obtained for the primary reference in the specified operating pressure range. If the service gas and calibration gas are the same, the measured gas is ensured to be ±1% of full scale in the specified operating pressure range as to our primary reference.
Note 2—The proof pressure specification does not ensure operation or accuracy.

MFC DIMENSIONS

Dimensions for Standard MFC Models

Figure 6-1 and Table 6-33 provide physical dimensions for standard MFC model numbers.

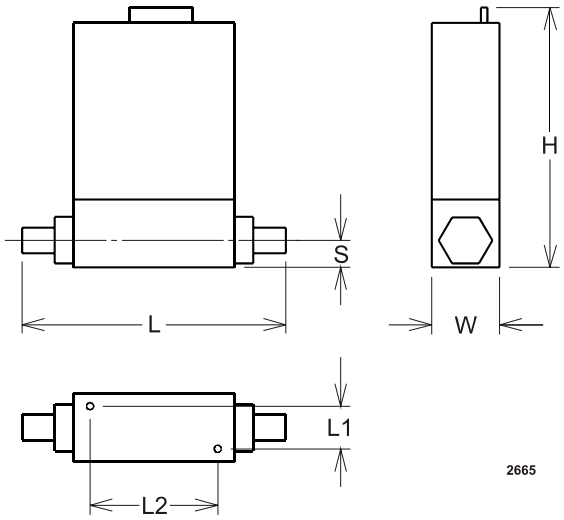


Figure 6-1. *Dimensions for standard MFC models with 1/4″ VCR fitting*

Table 6-33. *Dimensions for standard models in mm (and inches)*

Model	L	S	H	W	L1	L2
FC-770A / 770AC	124 (4.88)	12.7 (0.50)	127 (5.00)	32 (1.26)	22 (0.87)	66 (2.60)
FC-771A / 771AC	124 (4.88)	15 (0.59)	127 (5.00)	32 (1.26)	22 (0.87)	66 (2.60)
FC-772 / 772C	**1/4″ VCR fitting:** 183.8 (7.24) **3/8″ VCR fitting:** 192.3 (7.6)	15 (0.59)	152.6 (6.01)	37.5 (1.48)	25.5 (1.00)	101.5 (4.00)
FC-780 / 780C	124 (4.88)	12.7 (0.50)	122 (4.80)	32 (1.26)	18 (0.71)	69 (2.72)
FC-781 / 781C	151 (5.94)	19 (0.75)	128 (5.04)	38 (1.50)	28 (1.10)	46 (1.81)
FC-782 / 782C	**1/4″ VCR fitting:** 183.8 (7.24) **3/8″ VCR fitting:** 192.3 (7.6)	15 (0.59)	152 (5.98)	38 (1.50)	25.5 (1.00)	90 (3.54)
FC-780X / 780XC	124 (4.88)	12.7 (0.50)	122 (4.80)	32 (1.26)	18 (0.71)	69 (2.72)

Table 6-33. *Dimensions for standard models in mm (and inches) (Continued)*

Model	L	S	H	W	L1	L2
FC-790 / 790C (second numbers under L1 and L2 refer to additional mounting holes)	124 (4.88)	12.7 (0.50)	125 (4.92)	38 (1.50)	18.6 (0.73)	38.2 (1.50)
					18 (0.71)	69 (2.72)
FC-791 / 791C (second numbers under L1 and L2 refer to additional mounting holes)	124 (4.88)	12.7 (0.50)	131.6 (5.18)	38 (1.50)	18.6 (0.73)	38.2 (1.50)
					18 (0.71)	69 (2.72)
FC-795 / 795C	106 (4.17)	12.7 (0.50)	125 (4.92)	38 (1.50)	16 (0.63)	29 (1.14)
FC-796 / 796C	106 (4.17)	12.7 (0.50)	131.6 (5.18)	38 (1.50)	16 (0.63)	29 (1.14)
FC-7700 / 7700C	124 (4.88)	12.7 (0.50)	127 (5.00)	32 (1.26)	22 (0.87)	66 (2.60)
FC-7700CD / 7700CU	124 (4.88)	12.7 (0.50)	125 (4.92)	32 (1.26)	18.3 (0.72)	69 (2.72)
FC-7710 / 7710C	124 (4.88)	15 (0.59)	127 (5.00)	32 (1.26)	22 (0.87)	66 (2.60)
FC-7710CD / 7710CU	124 (4.88)	12.7 (0.50)	125 (4.92)	32 (1.26)	18.3 (0.72)	69 (2.72)
FC-7720 / 7720C / 7720CD	**1/4″ VCR fitting:** 183.8 (7.24) **3/8″ VCR fitting:** 192.3 (7.6)	15 (0.59)	152.6 (6.01)	37.5 (1.48)	25.5 (1.00)	101.5 (4.00)
FC-7800 / 7800C	124 (4.88)	12.7 (0.50)	122 (4.80)	32 (1.26)	18 (0.71)	69 (2.72)
FC-7800CD / 7800CU	124 (4.88)	12.7 (0.50)	125 (4.92)	32 (1.26)	18 (0.71)	69 (2.72)
FC-7810 / 7810C	151 (5.94)	19 (0.75)	128 (5.04)	38 (1.50)	28 (1.10)	46 (1.81)
FC-7810CD / 7810CU	124 (4.88)	12.7 (0.50)	131 (5.16)	38 (1.50)	18.3 (0.72)	69 (2.72)
FC-7820 / 7820C	**1/4″ VCR fitting:** 183.8 (7.24) **3/8″ VCR fitting:** 192.3 (7.6)	15 (0.59)	152 (5.98)	38 (1.50)	25.5 (1.00)	90 (3.54)

Table 6-33. *Dimensions for standard models in mm (and inches) (Continued)*

Model	L	S	H	W	L1	L2
FC-785 / 785C	106 (4.17)	12.7 (0.50)	123.8 (4.87)	36 (1.42)	16 (0.63)	29 (1.14)
FC-786 / 786C	106 (4.17)	12.7 (0.50)	123.8 (4.87)	36 (1.42)	16 (0.63)	29 (1.14)

Dimensions For Block-Type MFC Models

Figure 6-2 and Table 6-34 provide physical dimensions for block-type MFC model numbers.

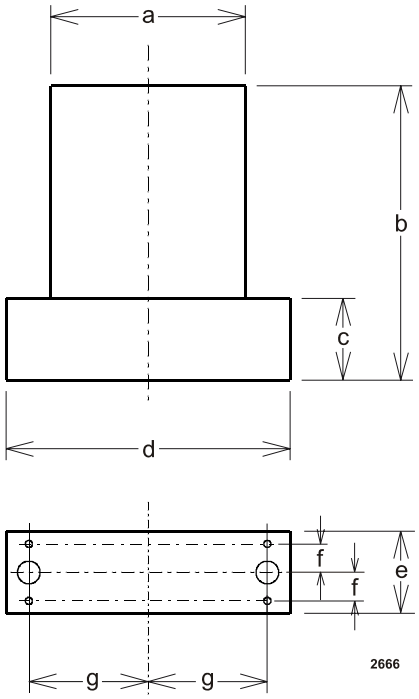


Figure 6-2. *Dimensions of block-type MFC models*

Table 6-34. *Dimensions for block-type models in mm (and inches)*

Model	a	b	c	d	e	f	g
FC-7850Y-B FC-7850CY-B FC-785Y-B FC-785CY-B FC-786Y-B FC-786CY-B FC-785T-B FC-785CT-B FC-786T-B FC-786CT-B FC-795T-B FC-795CT-B	63.6 (2.50)	180 (7.09) maximum	40 (1.57) maximum	99.5 ±6.5 (3.92 ±0.26)	38 (1.50)	15 (0.59)	39.9 (1.57)
FC-785X-B FC-785XC-B	68 (2.68)	180 (7.09) maximum	40 (1.57) maximum	99.5 ±6.5 (3.92 ±0.26)	38 (1.50)	15 (0.59)	39.9 (1.57)

Dimensions for High Temperature MFC Models

Figure 6-3, Table 6-35, and Table 6-36 provide physical dimensions for the high temperature MFC model numbers (for both the MFC unit and the PCB unit).

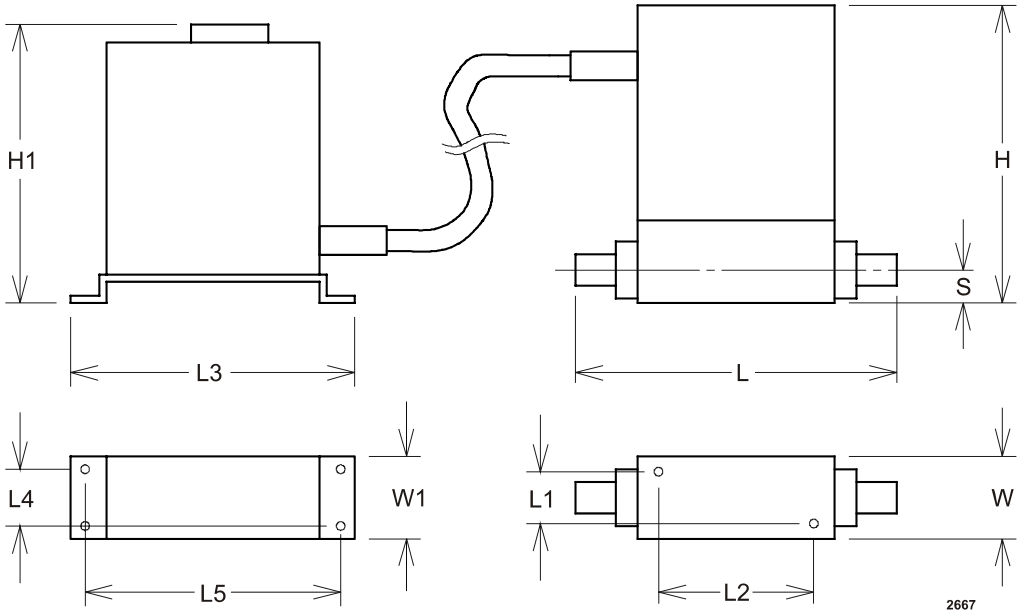


Figure 6-3. *Dimensions for high temperature MFC models*

Table 6-35. *Dimensions of high temperature MFC units in mm (and inches)*

Model	L	S	H	W	L1	L2
FC-780HT / 780CHT	124 (4.88)	12.7 (0.50	107 (4.21)	32 (1.26)	18 (0.71)	69 (2.72)
FC-781HT / 781CHT	151 (5.94)	19 (0.75)	113 (4.45)	38 (1.50)	28 (1.10)	46 (1.81)

Table 6-36. *Dimensions of high temperature PCB units in mm (and inches)*

Model	L3	H1	W1	L4	L5
FC-780HT / 780CHT	102 (4.02)	84 (3.31)	32 (1.26)	22 (0.87)	92 (3.62)
FC-781HT / 781CHT	102 (4.02)	84 (3.31)	32 (1.26)	22 (0.87)	92 (3.62)

REFERENCE INFORMATION

The following sections contain calibration references, as well as MFC label and model code information for the MFC.

Calibration References

In order to ensure MFC cleanliness, AE may use a surrogate calibration gas rather than the gas indicated on the label. The calibration ambient temperature is 22ºC. (If the MFC requires a different ambient calibration temperature, that temperature is indicated on the MFC label.)

Note: The calibration gas and its conversion factors are subject to change due to technological innovation or changes in environmental regulations.

Table 6-37. *Calibration references*

Description	Specification
Calibration method	Primary, secondary, or rate of rise of N_2 (or other surrogate gas)
Reference conditions	0ºC / 760 Torr per SEMI E12-96
Traceablity	All calibrations are traceable to Japan standards and/or United States standards (NIST)

FLOW INDICATION

Flow rate is indicated by standard cubic centimeters per minute (sccm), cubic centimeters per minute (ccm), standard liters per minute (slm), and liters per minute (lm) as follows:

- For sccm and slm, gas flow rates at 0ºC, 101.3 kPa
- For ccm and lm, gas flow rate at customer-defined temperature, 101.3 kPa

Note: Unless otherwise noted, sccm and slm are used for calibration.

Product Label

The MFC product label displays the following: model number, serial number, calibration gas, surface treatment, and full-scale flow. Figure 6-4 is an example of a MFC single-gas model label.

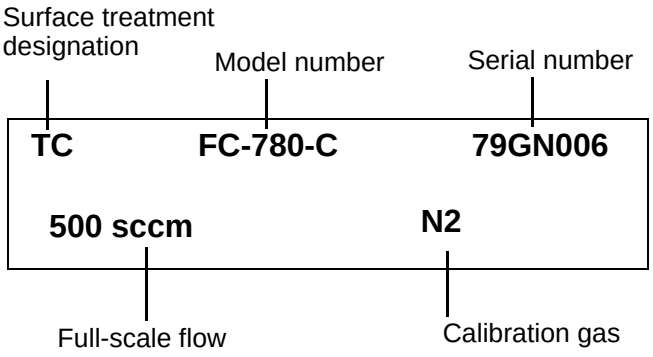


Figure 6-4. *MFC label example*

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